The American Midland Naturalist

Founded by J. A. Nieuwland, C.S.C.

Theodor Just, *Editor*

John D. Mizelle, *Managing Editor*

CONTENTS

Vol. 37 May, 1947 No. 3

11

EDITORIAL STAFF

NOTE: THE AMERICAN MIDLAND NATURALIST, published by the University of Notre Dame, is primarily, though not exclusively, devoted to the Natural History of the Middle West. A wide selection of papers on botany, paleontology and zoology is published in bi-monthly issues, three of which make up a volume.

Twenty-five reprints will be given free of charge provided, at least, an equal number is ordered. Authors are requested to submit carefully prepared manuscripts and to limit tables and illustrations as far as possible. Abstracts should accompany manuscripts.

The following numbers are out of print: Vol. 1 (1, 5, 10-12); Vol. 2 (1-3, 8-10); Vol. 3 (all numbers); Vol. 4 (1-9, 11, 12); Vol. 5 (1, 6-8); Vol. 6 (1, 5, 7-12); Vol. 7 (6-12); Vol. 8 (2,3); Vol. 9 (4, 9); Vol. 10 (11); Vol. 11 (1); Vol. 12 (12); Vol. 13 (2); Vol. 14 (1, 5, 6); Vol. 15 (4); Vol. 21 (3); Vol. 23 (3); Vol. 24 (3); Vol. 25 (1,2); Vol. 26 (2); Vol. 27 (1); Vol. 28 (1-3); Vol. 29 (1, 3); Vol. 30 (1); Vol. 36 (1). Available issues of Vols. 1-14, 30 cents per copy; complete volumes, $3.00 each, except Volumes 7, 13, and 14, $1.50 each; Vol. 15, $2.00, single issues, 35 cents; Vol. 16, $3.00, single issues, 50 cents; Vol. 17, $4.50, Part I, $2.00, nos. 2-6, 50 cents each; Vol. 18, $3.00, single issues, 50 cents; Vols. 19-33, $2.50 each, single issues, $1.00. Subscription price per year, $5.00.

Exchanges for journals, special volumes or duplicate books, and specimens should be arranged directly through the editorial office at the University of Notre Dame, where subscriptions also are received. Offers should accompany request for exchange.

For citation use this abbreviation: *Amer. Midl. Nat.*

The *American Midland Naturalist* is indexed in the INTERNATIONAL INDEX.

Entered as second-class matter at Notre Dame, Indiana. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on July 3, 1918.

T

Vo

St
pa
Ar
in
'S
Th
M
og
co
tra
of
W
Er
th
to
bo
we
of
pr
we
de
tre
og
su
to
th
ge
ar
th
th
di
th
th

The American Midland Naturalist

Published Bi-Monthly by The University of Notre Dame, Notre Dame, Indiana

Vol. 37 MAY, 1947 No. 3

A Generic and Subgeneric Synopsis of the United States Ants, Based on the Workers (Hymenoptera: Formicidae)

Marion R. Smith

The first comprehensive key for determining the ants of the United States to families and genera was published by E. T. Cresson in 1887, on pages 92-104 of the Supplementary Volume of The Transaction of The American Entomological Society. According to him the characters used in it were "compiled chiefly from the second volume of Andre's admirable 'Species des Hymenopteres d' Europe' which was published in 1882-1883." The five families treated were the Poneridae, Odontomachidae, Dorylidae, Myrmicidae, and Formicidae. All except the Odontomachidae are now recognized as subfamilies, the Odontomachidae having been dropped from consideration as either a family or subfamily and the genus *Odontomachus* transferred to the Ponerinae. Cresson stated that approximately 200 forms of ants had been described from our fauna at that time. In 1902 W. M. Wheeler presented in the American Naturalist (46[429]:702-725) an English translation of Carlo Emery's "An Analytical Key to the Genera of the Family Formicidae, for the Determination of the Workers." In this key to the ants of the world Wheeler set off the Nearctic genera by means of boldface type. Both Cresson's key and Wheeler's translation of Emery's key were of inestimable value in that they furnished a basis for the development of future keys. In the 1910 edition of his noted book, "Ants," Wheeler produced a key of his own (Appendix B, pp. 557-560) for identifying our worker ants to subfamilies, genera, and subgenera. Fifty-one genera were dealt with, or 12 more than in Emery's key. Only 5 subfamilies were treated, as the Pseudomyrminae and the Cerapachyinae had not been recognized. The key had some distinct advantages over Emery's: First, it was supplemented by a list of all the ants known to occur in the United States together with the general distribution of each; second, throughout the book there were figures that could be considered more or less illustrative of the genera; and finally, at the end of the volume there was a bibliography of the ant literature of the world through the year 1908. At this time, however, the ant fauna of the United States was still very poorly known as was also the range of each form. The bibliography, although very helpful, had the disadvantage of being arranged alphabetically according to authors rather than having all important literature pertaining to a genus grouped under that genus. Regardless of these criticisms, the key and the information sup-

plementing it represented a great advance in the improvement of our knowledge of the ants of the United States. Besides the key mentioned there also have been published during the past 40 years a number of articles dealing with the ants of a single state or of a restricted area. Many have contained keys for identifying ants to subfamilies, genera, subgenera or even species. Though satisfactory for the identification of the forms of these areas, the papers have not been comprehensive enough to satisfy one interested in the ant fauna of the entire United States. There also has been much change in ant taxonomy since the publication of Wheeler's book. This has involved the recognition of 2 additional subfamilies (Cerapachyinae and Pseudomyrminae), 10 additional genera, 291 additional forms, these having increased from 451 to 742, and considerable changes with regard to synonymy, and generic and subgeneric concepts.

For years there has been a definite need for a taxonomic publication on the ants of the United States that would be up-to-date, comprehensive, and readily workable. This article represents an earnest effort to meet that demand. Although designed primarily for beginners in formicology and for those who are more or less casually interested in the subject, the publication should also prove helpful to others.

A member of the worker caste is the individual to which we commonly apply the name "ant." Its functions are primarily fighting, foraging, nursing, and caring for the nest. The worker ant differs from the female (queen) in that it is usually smaller, normally lacks wings, seldom bears ocelli except in certain restricted groups of ants, and has a thorax that appears to be composed of three divisions but which in reality is composed of four, the first abdominal segment of the embryo having fused with the metathorax to form a region known as the epinotum. Workers are designated as monomorphic when they are of similar size, dimorphic when there are two sizes, and polymorphic when there are more than two sizes. The major worker of both the dimorphic and polymorphic forms is commonly called soldier. Polymorphic workers are divided still further according to size into minor workers, intermediate workers, and major workers.

With certain exceptions, as in *Eciton* where all females are wingless, female ants are winged on reaching maturity, but lose or shed their wings later. An individual that has lost its wings can be readily distinguished from a normal worker by the extra sclerites composing the thorax.

This article is confined to a treatment of workers, except that females are considered in the case of those genera containing parasitic forms, in which workers are unknown. Major workers, or so-called soldiers, are especially treated in those genera that contain dimorphic or polymorphic workers. The keys to the subfamilies, genera, and subgenera are constructed for simplicity rather than for indication of phylogenetic affinities. They are supported by numerous illustrations representing one form of nearly every genus or subgenus. In many points in the keys there are statements pertaining to the distribution or abundance of certain ants, or even remarks on the biology. Each subfamily, genus, and subgenus is characterized, and the genotype or subgenotype is cited, as is also the reference to the original description. Should

the reader wish to determine specimens beyond genera or subgenera he will find the important literature, whether taxonomic or biological, listed chronologically under the groups in which he is working. The articles containing keys to species are designated by an asterisk, and those which include illustrations are marked "illus."

The present work contains a list of explanations of both taxonomic and biological terms, and also a general index. All subfamilies, genera, subgenera, and forms are listed both in the general index and under each genus or subgenus to which they belong.

Anyone who has studied biological material extensively is always impressed by the extent of variation that occurs among individuals composing the same taxonomic unit. Because of such variation a given specimen may not fully agree with all the characters in a key or in a generic or specific description. In the genus *Pogonomyrmex,* for example, workers are usually considered as having no promesonotal or mesoepinotal sutures dorsally, yet specimens that have such sutures are often encountered definitely belonging to the genus. One also has the impression, after having examined thousands of specimens belonging to various species of *Aphaenogaster,* that epinotal spines are one character that is common to them all, yet there are a few species in this group whose workers have no spines or only faint tubercles in place of spines. The genus *Pheidole* normally has dimorphic workers, and one can look at specimens in species after species where this holds true, yet there are a few species such as *instabilis* and *rhea* that have polymorphic workers. The possibility of such discrepancies must be taken into account.

Although most ants are free-living forms, a few have become parasites on others of their kind. The genera *Anergates, Epoecus,* and *Sympheidole* possessing this habit have apparently lost their worker caste and are now represented only by males and females. There are also some genera which, although they are comprised mostly of free-living forms, contain a few parasitic species, as for example, *Leptothorax* (*Mychothorax*) with *emersoni* and *diversipilosus, Crematogaster* (*Acrocoelia*) with *kennedyi* and *creightoni,* and *Myrmica* (*Manica*) with *parasitica.*

Sixty-one genera of ants are recognized in this publication, these being distributed among the subfamilies as follows: Dorylinae, 1; Cerapachyinae, 2; Ponerinae, 11; Pseudomyrminae, 1; Myrmicinae, 32; Dolichoderinae, 6; Formicinae, 8. The 743 forms are distributed among the subfamilies as follows: Dorylinae, 20; Cerapachyinae, 3; Ponerinae, 31; Pseudomyrminae, 5; Myrmicinae, 385; Dolichoderinae, 27; and Formicinae, 272.

The genera new to our country since the publication of Wheeler's "Ants," in 1910 are *Anergates, Cardiocondyla, Ectatomma, Triglyphothrix,* and *Wasmannia.* All have apparently been introduced except one of the subgenera of *Ectatomma,* which evidently is native. Since *Anergates atratulus,* a parasite of the introduced *Tetramorium caespitum,* has recently been discovered in the United States, it is only natural to infer that one or possibly more forms of *Strongylognathus,* which are also parasites on *T. caespitum,* may be found eventually. Undoubtedly there are many undescribed ants. As indicative of this, only 8 forms of *Strumigenys* had been recorded prior to 1931, when

the discovery of additional forms (mostly new to science) enlarged the list to 16. At present there are 27 described forms or approximately three and one-half times as many as were known before 1931. The number of forms comprising our entire ant fauna is now approximately one and two-thirds times as great as in 1910. Probably the best opportunities for future collecting will be in the extreme northern, southeastern, and southwestern parts of the country.

Although more formicologists have worked on our ants during the past 30 years than during any similar previous period an immense amount of work still remains to be done in revising genera, and in determining the distributional ranges and the preferred ecological habitats of the various forms.

This article is based on a study of specimens in the United States National Museum, in the personal collection of W. M. Mann, and in that of the Museum of Comparative Zoology of Harvard University. The forms actually studied are indicated by a dagger (†). The illustrations were drawn by Sara H. DeBord and Arthur D. Cushman. The DeBord figures bearing the numeral '31 were originally made for the author when he was employed by The Mississippi State Plant Board.

The measurements given for the workers under each genus and subgenus include the range in length from the smallest known worker to the largest known worker in the same group. In many genera the range is so great that the measurements can mean very little, but in some the length of the worker is of aid in determination, as in the genus *Brachymyrmex*. The following explanations are offered for the various measurements mentioned throughout the article. The length of the head is the median length from the anterior border of the clypeus to the posterior border of the head. The length of the antennal scape is the distance from its insertion in the antennal fossa to the tip of the scape. The amount the scape surpasses the posterior border of the head is the distance from the antennal fossa to the posterior border of the head through the most direct line deducted from the length of the scape. The position the eye occupies with relation to the midlength of the side of the head is obtained by measuring on the side of the head from the posterior border of the clypeus to the posterior border of the head and determining if most or all of the eye is anterior or posterior to a point midway between these two. Reference to tibial spurs applies to the spur near the apex of each middle and hind tibia.

KEY TO SUBFAMILIES

1. Abdominal pedicel composed of two segments, the petiole and postpetiole. Pl. 6, fig. 23 2

   Abdominal pedicel composed of a single segment, the petiole. Pl. 22, fig. 84 4

2. (1) Frontal carinae located very close to each other and not covering the antennal insertions. Pl. 5, fig. 17 3

   Frontal carinae not placed close to each other and each often bearing a lobe which more or less conceals the antennal insertion. Pl. 5, fig. 18. (Clypeus almost always prolonged back between the frontal carinae. One of the largest subfamilies.) .... *Myrmicinae* Lepeletier, p. 543

3. (2) Eye remarkably large, reniform or subelliptical, occupying approximately half

the length of the side of the head. Ocelli usually present. (Clypeus not prolonged back between the frontal carinae. Pl. 5, fig. 17. Median spur of each middle and hind tibia pectinate.) ....*Pseudomyrminae* Emery, p. 542

Eye either absent or else vestigial, ocellus-like. No ocelli. Pl. 1, fig. 2. ....*Dorylinae* Leach, p. 525

4. (1) Cloacal orifice circular, terminal, surrounded by a fringe of hairs. (Gaster without a pronounced constriction between the first and second segments. Pl. 21, fig. 80. Antennal fossa not always touching the posterior border of the clypeus. One of the largest subfamilies.) ....*Formicinae* Lepeletier, p. 599

Cloacal orifice not as described 5

5. (4) No constriction between the first and second gastric segments. Pl. 17, fig. 65. Integument usually soft, flexible. Sting rudimentary or absent. (Anal glands present which produce a characteristic, disagreeable "tapinoma odor." Antennal fossa touching posterior border of clypeus. Eye located well toward the median line of the head.) Pl. 17, fig. 65 ....*Dolichoderinae* Forel, p. 592

A pronounced constriction between the first and second gastric segments. Pl. 4, fig. 14. Integument firm, highly sclerotized. Sting well-developed. 6

6. (5) With a pygidium bearing distinct spines on its lateral and posterior borders. Pl. 1, fig. 3. (Petiole subcylindrical. Antenna located exceedingly close to the border of the mouth; funiculus much incrassated.) Extremely rare ants. Habitus not antlike. Texas and Arizona ....*Cerapachyinae* Forel, p. 528

Without a pygidium. Pl. 4, fig. 14. More common ants. Habitus usually antlike. One or more representatives in every state ....*Ponerinae* Lepeletier, p. 529

Subfamily Dorylinae Leach

Dorylida Leach, 1815, in Brewster's Edinb. Encycl. **9**:147.
Dorylinae Dalla Torre, 1893, Catal. Hymen. **7**:1.

Cloacal orifice ventral, slit-shaped. Sting developed. Pedicel consisting of 2 segments, the petiole and postpetiole. Frontal carinae very close to each other, almost vertical, not covering the antennal insertions. Compound eyes absent or extremely small (vestigial), ocelluslike. No ocelli. Antenna inserted exceedingly close to the mouth, 12-segmented; often short and much incrassated. Clypeus remarkably short. In some species, posterior corner of head extended as an angular process. Promesonotal suture obsolescent or absent. Pupae of workers apparently never borne in cocoons. Nests commonly constructed in rotten logs and stumps or in the soil beneath stones and other objects. Colonies usually very large. Ants highly predaceous on termites, on the brood of other ants, and on various other insects. Workers travel in distinct files while foraging or moving nests. Twenty forms; these distributed mainly south of the 40th degree of latitude with a slight northward extension in the Mississippi Valley region. Uncommon.

1. Tarsal claw with a median tooth. Pl. 1, fig. 1. ....*Eciton*, subg. *Labidus* Jurine, p. 525

Tarsal claw simple, without a tooth. Pl. 1, fig. 2. ....*Eciton*, subg. *Neivamyrmex* Borgmeier, p. 527

ECITON, subgenus LABIDUS Jurine

Pl. 1, Fig. 1

Labidus Jurine, 1807, Nouvelle Méthode de Classer les Hymenóptéres et les Diptéres, p. 282.

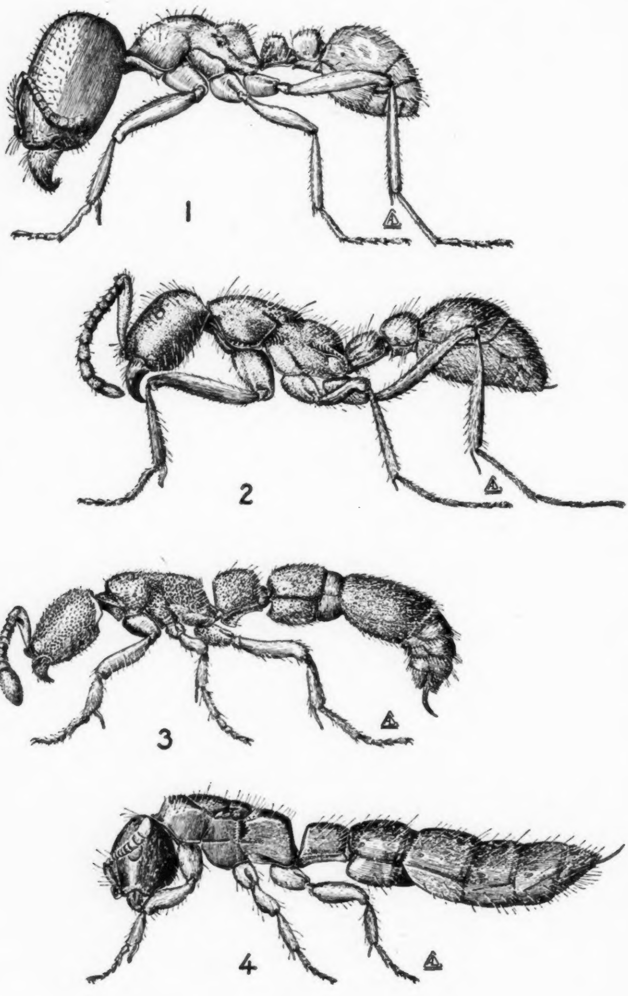


PLATE 1

Fig. 1. *Eciton* (*Labidus*) *coecum* (Latreille), major worker.
Fig. 2. *Eciton* (*Neivamyrmex*) *nigrescens* (Cresson), worker.
Fig. 3. *Cerapachys* (*Parasyscia*) *augustae* Wheeler, worker.
Fig. 4. *Acanthostichus* (*Ctenopyga*) *texanus* Forel, female.

Subgenotype, (*Labidus latreillei* Jurine) = *Formica coeca* Latreille (by designation of Latreille, 1810).
Latreille, 1802, Hist. Nat. Fourmis **9**:270, illus.
Mayr, 1886, Wien. Ent. Ztg. **5**:119.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:409.

Length 2.5-7 mm. Characters similar to those of *Eciton*, subg. *Neivamyrmex* except for toothed claws and the presence of a tooth on each frontal carina. Two forms, †*coecum* (Latreille) and *esenbeckii* (Westwood). *E. coecum* occurs in Texas, Louisiana, and Oklahoma, *esenbeckii* only in southern Texas. The worker of *esenbeckii* is not known but it is thought to be *crassicorne* (F. Smith). The description above applies only to *coecum*.

ECITON, subgenus NEIVAMYRMEX Borgmeier

Pl. 1, Fig. 2

Eciton, subg. *Acamatus* Emery, 1894, Soc. Ent. Ital. Bol. **26**:181. (*Acamatus* Emery preoccupied by *Acamatus* Schoenherr, 1833.)
Neivamyrmex Borgmeier, 1940, Rev. de Ent. **11**:606.
Subgenotype, (*Eciton* (*Acamatus*) *schmitti* Emery) = *Labidus nigrescens* Cresson (by designation of Wheeler, 1911).
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:969.
*Emery, 1894, Soc. Ent. Ital. Bol. **26**:183, 184.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:258.
Emery, 1900, Mem. Real. Accad. Sci. Bologna **8**:522.
Emery, 1901, Soc. Ent. Ital. Bol. **33**:55, illus.
Wheeler, 1903, Psyche **10**:93, illus.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:410-413, illus.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:392.
*Smith, 1942, Amer. Midl. Nat. **27**:537, illus.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:280.

Polymorphic. Length 1.75-6 mm. Frontal carinae closely approximate, almost vertical, and not covering antennal insertions. Cheek longitudinally carinate. Eye absent or extremely small to small, often not easily discernible. Posterior corner of head usually produced and angular. Antenna 12-segmented; scape short, robust, usually not extending much beyond posterior border of eye; funicular segments often incrassated. Dorsum of thorax without promesonotal suture; mesoepinotal suture generally represented by a broad impression. Epinotum unarmed. Tarsal claw simple. Petiole longer than postpetiole, usually produced beneath into a spine or tubercle. Eighteen forms, *arizonense* Wheeler, †*californicum* Mayr, †*carolinense* Emery, †*commutatum* Emery, *fuscipennis* Wheeler, *harrisii* (Haldeman), †*leonardi* Wheeler, †*melanocephalum* Emery, *melsheimeri* (Haldeman), *minus* (Cresson), *mojave* M. R. Smith, †*nigrescens* (Cresson), †*opacithorax* Emery, *oslari* Wheeler, †*pauxillum* Wheeler, †*pilosum* F. Smith, *pilosum mandibulare* M. R. Smith, †*wheeleri* Emery. Only the male is known for *arizonense, fuscipennis, harrisii, melsheimeri, minus, mojave, oslari, pilosum mandibulare*. The ants are distributed mainly south of the 40th degree of latitude with a slight northward extension in the Mississippi Valley region. They have nomadic, predatory habits, colonizing for temporary periods in the ground or in rotten logs and stumps. The colonies are large to very large. In this subgenus there doubtless is a great deal of synonymy which cannot be

ascertained until associated workers, males, and females are collected from the same colony.

Subfamily Cerapachyinae Forel

Cerapachysii Forel, 1893, Soc. Ent. de Belg. Ann. **37**:162.
Cerapachyinae Wheeler, 1920, Psyche **27**:51.

Cloacal orifice ventral, slit-shaped. Sting well-developed. Pedicel consisting of a single segment, the petiole. Gaster with a very pronounced constriction between the first and second segments. Pygidium margined laterally and posteriorly by distinct spines. Legs short. Each middle and hind tibia with a well-developed pectinate spur. Tarsal claw simple. Dorsal sutures of thorax absent or obsolescent. Antenna located exceedingly close to the border of the mouth; 11- or 12-segmented, heavily incrassated. Clypeus remarkably short. Eyes apparently absent. Integument firm, highly sclerotized. Nests constructed in the soil. Colonies exceedingly small, consisting of a dozen or so individuals. Predaceous and carnivorous. Extremely rare. Not antlike. Only 3 forms are known, these having been recorded from Arizona and Texas.

1. Antenna 11-segmented, the last segment unusually enlarged forming a club which is approximately as long as the combined length of the 5 preceding segments. (Eye apparently absent.) Carina laterad of antennal fossa well-developed, sharp. Frontal carinae closely approximate, high, projecting, not concealing antennal insertions. Texas and Arizona. Pl. 1, fig. 3. .... *Cerapachys*, subg. *Parasyscia* Emery, p. 528

   Antenna 12-segmented, last segment not forming a distinct club such as the one described above. (Eye presumably absent.) No carina laterad of antennal fossa. Frontal carina partly concealing antennal insertion by the extension of its lobe. Texas. Pl. 1, fig. 4. ....*Acanthostichus*, subg. *Ctenopyga* Ashmead, p. 529

CERAPACHYS, subgenus PARASYSCIA Emery

Pl. 1, Fig. 3

Parasyscia Emery, 1882, Andre's Species des Hyménopterés d'Europe et d'Algerie **2**:235.
Subgenotype, *Parasyscia piochardi* Emery (monobasic).
Wheeler, 1902, Biol. Bul. **3**:181, illus.
Wheeler, 1903, Psyche **10**:205, illus.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:401.
Wheeler, 1926, Ants, Columbia Univ. Press, 2nd ed., p. 226, illus.

Length 2.5-3.5 mm. Eyes apparently absent. Posterior border of head distinctly emarginate; posterior corners sharply angular, projecting. Antenna 11-segmented; scape short, curved, stout, greatly enlarged apically, not extending much beyond the middle of the head; all funicular segments except the first and last broader than long, last segment unusually enlarged forming a club which is approximately as long as the 5 preceding segments combined. Carina laterad of antennal fossa well-developed, sharp. Frontal carinae closely approximate, high, projecting, not concealing the antennal insertions. Mandible subtriangular, with indistinctly crenated masticatory border. Thorax subcylindrical, with dorsal sutures obsolescent or absent. Legs rather short; spur of each middle and hind tibia distinctly pectinate. Tarsal claw simple.

First gastric segment separated from the second by an unusually strong constriction; second gastric segment flattened dorsally and occupying approximately half of the gaster. Apical segment of the gaster (pygidium) with small but distinct spines on its lateral and posterior borders. Two forms, †*augustae* Wheeler and *davisi* M. R. Smith. The former has been recorded from Texas and Arizona, the latter only from Texas. The worker caste of *davisi* is not yet known. Extremely rare. Nests in the soil, usually beneath stones or other objects. Colonies unusually small. Predaceous, also carnivorous.

ACANTHOSTICHUS, subgenus CTENOPYGA Ashmead

Pl. 1, Fig. 4

Ctenopyga Ashmead, 1905, Canad. Ent. **37**: 382 (nomen nudum); 1906, Ent Soc. Wash. Proc. **8**:29.
Subgenotype, *Ctenopyga townsendi* Ashmead (by original designation).
Wheeler, 1902, Biol. Bul. **3**:187, illus.
Forel, 1904, Soc. Ent. de Belg. Ann. **48**:168.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:400.

Worker unknown. The females of *texanus* Forel and *townsendi* Ashmead are respectively 5.6 and 5 mm. each. The workers of this subgenus can be expected to have most or all of the following characters: Body slender. Head subrectangular. Antenna 12-segmented; scape stout, flattened, not extended beyond the midlength of the head; funiculus short, clavate. Frontal carinae partly concealing antennal insertions. Mandible large, subtriangular, strongly concave beneath; masticatory border apparently without teeth or denticulae. Thorax apparently not marginate, with the dorsal sutures obsolescent or absent. Legs short, each tibia with a well-developed, pectinate spur. Tarsal claws simple. Petiole, from above, subcylindrical, also not marginate, much narrower than the first gastric segment and separated from it by a strong constriction. First gastric segment separated from the second by a very pronounced constriction. Fifth gastric segment (pygidium) with a declivous surface margined laterally and posteriorly by distinct spines. One form, *texanus* Forel, which has been collected in Brownsville and Rio Grande City, Tex. Extremely rare. Nests in the soil. Colonies unusually small. Predaceous, also carnivorous.

Subfamily Ponerinae Lepeletier

Ponerites Lepeletier, 1836, Hist. Nat. Ins. Hymen. **1**:185.
Ponerinae Dalla Torre, 1893, Catal. Hymen. **7**:13.

Cloacal orifice ventral, slit-shaped. Sting well-developed. Pedicel with a single segment, the petiole. Gaster with a pronounced constriction between the first and second segments. Frontal carinae separated or close together, when close together they are usually dilated to form oblique or horizontal lobes, partly covering the antennal insertions. Integument firm, strongly sclerotized. Pupae always enclosed in cocoons. Nests constructed in the soil or in rotting wood. Many of the forms have vestigial eyes and to a greater or less extent avoid the light. Colonies small, consisting of a few hundred individuals or less. Almost exclusively flesh eating; both predaceous

and carnivorous. Thirty-one forms. More common in the southern half of the United States, but a few genera, such as *Ponera* and *Stigmatomma,* apparently occur in every state. None of the forms is considered inimical to man's welfare.

1. Apex of gaster directed ventrally or anteroventrally. (Dorsal sutures of thorax absent or obsolescent. Eye extremely small, not easily discernible. Extremely rare or rare.) Pl. 2, fig. 6 2

Apex of gaster not directed ventrally or anteroventrally. Pl. 2, fig. 8 3

2. (1) Petiole scalelike. Anterior border of clypeus not projecting in the middle. Rare. Distributed mainly over the southeastern fourth of the United States. Pl. 2, fig. 6 .... *Proceratium* Roger, p. 535

Petiole more or less nodiform. Anterior border of clypeus projecting in the middle. Extremely rare. Distributed over approximately the eastern half of the United States. Pl. 2, fig. 7 .... *Sysphincta* Roger, p. 536

3. (1) Mandible with a row of coarse, bidenticulate teeth. Anterior border of clypeus denticulate. (Inferior angle of head usually with a pronounced tooth. Eye unusually small and inconspicuous, placed in the posterior half of the side of the head. Uncommon. Distributed over the entire United States.) Pl. 2, fig. 5 .... *Stigmatomma* Roger, p. 531

Mandible and clypeus not as described above 4

4. (3) Tarsal claw very distinctly pectinate. Pl. 4, fig. 15a. (Clypeus extended in the middle of its anterior border as an acute point. A sharp median carina throughout the length of the clypeus. Antennal scape extending approximately one-third its length beyond the posterior corner of the head. Frontal carinae closely approximate, each without a well-developed lobe, thus exposing most of the antennal insertion. Texas, Louisiana and Florida.) Pl. 4, fig. 15 .... *Leptogenys*, subg. *Lobopelta* Mayr, p. 540

Tarsal claw either simple or toothed, never pectinate 5

5(4) Mandibles linear, attached to the middle of the anterior margin of the head, so that when closed they lie subparallel to each other. Each section of head with a groove between eye and frontal carina extending posteromesially to converge above near the vertex. Another strong groove posterior to eye, running obliquely from the ventral to the dorsal surface of the head. Petiole extended above as a conical or spine-shaped structure. (Florida, Georgia, Louisiana, Texas and Arizona.) Pl. 4, fig. 16 .... *Odontomachus* Latreille, p. 541

Not the above combination of characters 6

6. (5) Cheek with a prominent carina extending from the eye to the clypeus. (Pronotum marginate on each side. Length 12-13 mm. Southern Texas.) Pl. 3, fig. 11 .... *Neoponera*, subg. *Neoponera* Emery, p. 536

Cheek without a carina 7

7. (6) Pronotum marginate on each side. (Length 7-8.5 mm. Texas and Louisiana.) Pl. 2, fig. 8 .... *Pachycondyla*, subg. *Pachycondyla* F. Smith, p. 537

Pronotum not marginate on each side 8

8. (7) Tarsal claw simple 10

Tarsal claw toothed or bifid. (Frontal carinae remote from each other.) 9

9. (8) Tarsal claw toothed. (Each middle and hind tibia with 2 spurs. Clypeus flat. Posterior border of petiole with an angle or tubercle on each side, mesad of which there is a broad but gentle convexity. Body covered with fine, dense, closely appressed, pruinose pubescence, and coarse, pitlike impressions. Southern Florida, Southern Texas.) Pl. 3, fig. 9 .... *Platythyrea* Roger, p. 533

Tarsal claw bifid. Pl. 3, fig. 10a. .... *Ectatomma* F. Smith

a. Posterior coxa with a dorsal spine. Apex of antennal scale almost reaching the

posterior corner of the head. Length approximately 3 mm. Sculpture for the most part longitudinally rugulose. One form, *hartmanni* Wheeler of Texas. ....*Ectatomma*, subg. *Parectatomma* Emery, p. 535

Posterior coxa without a dorsal spine. Apex of antennal scape extending considerably beyond the posterior corner of the head. Length 7-9.5 mm. Sculpturing on head and thorax mostly rugulose or rugulose-reticulate. (Posterior border of clypeus forming a smooth, somewhat hemispherical convexity over the antennal socket.) An introduced form, *tuberculatum* (Olivier) of Victoria County, Tex.; probably extinct there. Pl. 3, fig. 10 ....*Ectatomma*, subg. *Ectatomma* F. Smith, p. 533

10. (8) Tibiae of middle and hind legs each with a single spur. (Eye extremely small, often scarcely perceptible. Mesonotum not strongly protuberant or surrounded by a deeply impressed suture. Metatarsus of middle leg without stiff bristles on its extensor surface. Entire United States.) Pl. 4, fig. 14 ....*Ponera* Latreille, p. 540

Tibiae of middle and hind legs each with 2 spurs, the smaller of which is not always easily seen ....*Euponera* Forel

a. Metatarsus of middle leg without stiff bristles on its extensor surface. Mesonotum strongly protuberant, surrounded by a deeply impressed suture. Most of meso- and metapleura usually smooth and shining. One form, *solitaria* (F. Smith), accidentally introduced into several towns in Georgia, North Carolina, and Virginia. Pl. 3, fig. 12 ....*Euponera*, subg. *Brachyponera* Emery, p. 537

Metatarsus of middle leg with strong bristles on its extensor surface. Mesonotum not strongly protuberant or surrounded by a deeply impressed suture. Meso- and metapleura not always smooth and shining. (Uncommon.) Two forms, *stigma* (Fabricius) of Florida, and *gilva* (Roger) of Alabama, Mississippi, Louisiana, Tennessee and Texas. Pl. 4, fig. 13 ....*Euponera*, subg. *Trachymesopus* Emery, p. 539

STIGMATOMMA Roger

Pl. 2, Fig. 5

Stigmatomma Roger, 1859, Berlin. Ent. Ztschr. **3**:250.
Genotype, *Stigmatomma denticulatum* Roger (by designation of Bingham, 1903).
Haldeman, 1844, Acad. Nat. Sci. Phila. Proc. **2**:54.
Wheeler, 1900, Biol. Bul. **2**:56, illus.
Santschi, 1913, Soc. Ent. de Belg. Ann. **57**:429.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:389.
Haskins, 1928, N. Y. Ent. Soc. Jour. **36**: 179.
Cole, 1940, Amer. Midl. Nat. **24**:35.
*Creighton, 1940, Amer. Mus. Novitates No. 1079, p. 1, illus.

Length approximately 4-6.5 mm. Mandible linear, the inner border with a row of coarse, bidenticulate teeth, the apex ending in a long curved tooth. Anterior border of clypeus denticulate. Inferior angle of head usually with a pronounced tooth. Antenna 12-segmented, the scape short, lacking approximately one-half its length of reaching the posterior border of the head. Eye unusually small and inconspicuous, placed in the posterior half of the side of the head. Each middle and hind tibia with a pair of spurs. Mesonotum forming a narrow strip of almost uniform width across the dorsum of the thorax. Petiole flattened above, beneath with a prominent protuberance. Head subopaque, the sculpture consisting mostly of dense punctures. Four forms, †*pallipes* (Haldeman), † *pallipes montigena* Creighton, †*pallipes oregonense* Wheeler, †*pallipes subterranea* Creighton. One or more of these

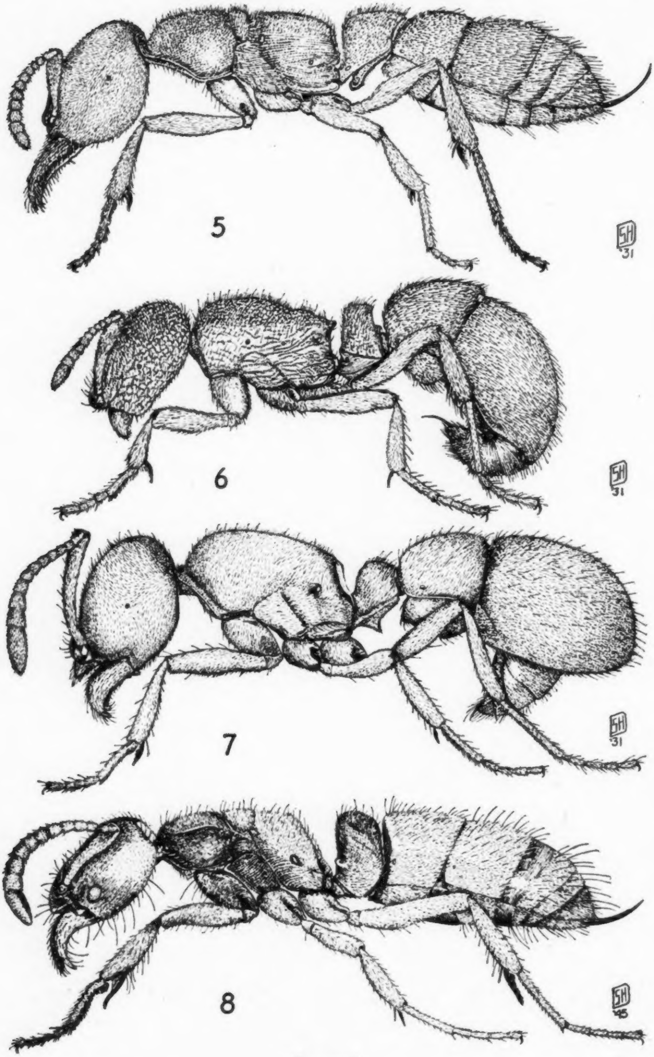


PLATE 2

Fig. 5. *Stigmatomma pallipes* (Haldeman), worker.
Fig. 6. *Proceratium croceum* (Roger), worker.
Fig. 7. *Sysphincta pergandei* Emery, worker.
Fig. 8. *Pachycondyla* (*Pachycondyla*) *harpax* (Fabricius), worker.

occur in every state. Uncommon. Usually found nesting in the soil of woodland areas beneath objects lying on the soil surface. Colonies small. Predaceous, also carnivorous. For a more detailed account of the biology see Wheeler 1900 and Haskins 1928.

PLATYTHYREA Roger

Pl. 3, Fig. 9

Platythyrea Roger, 1863, Berlin. Ent. Ztschr. **7**:172.
Genotype, *Pachycondyla punctata* F. Smith (by designation of Bingham, 1903).
F. Smith, 1858, Catalogue of Hymenopterous Insects in the Collection of the British Museum, pt. 6, p. 108.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:80, illus.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:401.
*Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:824.
*Mann, 1916, Harvard Univ. Mus. Compar. Zool. Bul. **60**:403.

Length 6-6.5 mm. Antennal insertions remote. Antenna 12-segmented, not clubbed. Scape robust, most of funicular segments as broad as long or broader than long. Frontal carina with a prominent lobe which helps to conceal the base of the antenna. Clypeus flat. Mandible subtriangular. Eye unusually large, with numerous ommatidia, placed nearer to the anterior half of the side of the head than the posterior half. Promesonotal suture pronounced, other sutures on dorsum of thorax apparently effaced. Epinotum with a pair of tubercles. Each middle and hind tibia with 2 spurs. Tarsal claw toothed. Posterior border of petiole with a lateral angle or tubercle, mesad of which there is a broad but gentle convexity. Body practically devoid of erect or suberect hair except at the apex of the gaster, but covered however with a fine, dense, closely appressed, pruinose pubescence. Coarse, pitlike impressions visible over most of the body. One form, †*punctata* (F. Smith) of extreme southern Florida, southern Texas. Uncommon. Nests in logs, stumps and under the bark of trees. Colonies small. Predaceous, also carnivorous.

ECTATOMMA, subgenus ECTATOMMA F. Smith

Pl. 3, Fig. 10

Ectatomma F. Smith, 1858, Catalogue of Hymenopterous Insects in the Collection of the British Museum, pt. 6, p. 102.
Subgenotype, *Formica tuberculata* Olivier (by designation of Bingham, 1903).
Olivier, 1791, Encycl. Meth. Ins. **6**:498.
Norton, 1868, Amer. Nat. **2**:61, illus.
Cook, 1904, Science N. S. **19**:862.
Cook, 1904, Science N. S. **20**:611.
Cook, 1904, U. S. Dept. Agr. Div. Ent. Bul. **49**:5-15.
Wheeler, 1904, Science N. S. **20**:437.
Wheeler, 1904, Science N. S. **20**:766-768.
Wheeler, 1905, Science N. S. **21**:706.

Length 7-9.5 mm. Eye with numerous ommatidia, prominent, very strongly convex; located posterior to the middle of the side of the head. Frontal carinae remote from each other, subparallel behind. Clypeus with curved anterior border, with a median carina extending throughout its length, posterior border forming on each side a smooth, somewhat hemispherical convexity over the antennal socket. Mandible unusually large, subtriangular,

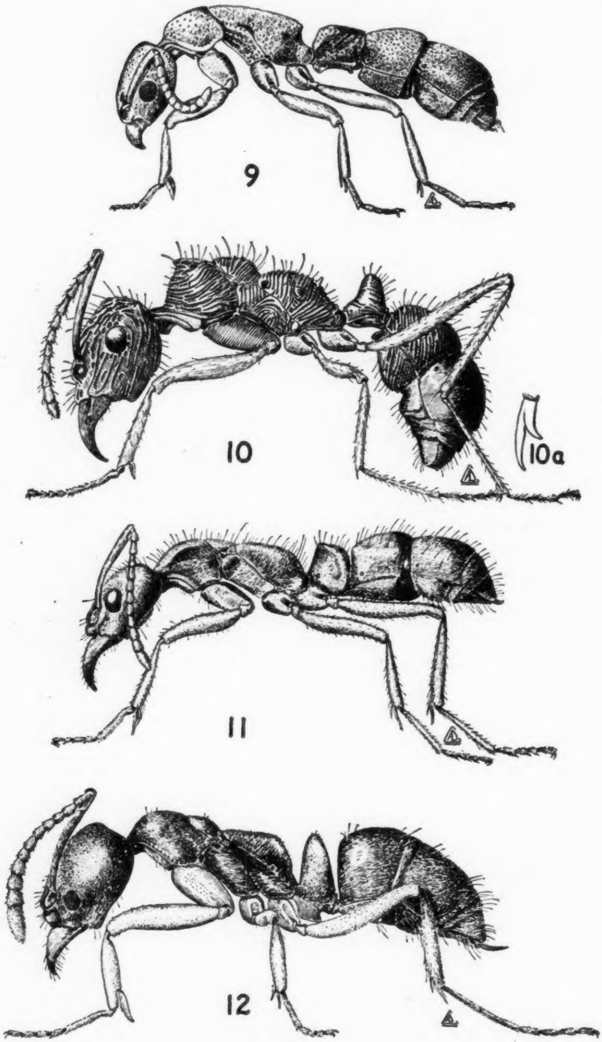


PLATE 3

Fig. 9. *Platythyrea punctata* (F. Smith), worker.
Fig. 10. *Ectatomma* (*Ectatomma*) *tuberculatum* (Olivier), worker; fig. 10 a, tarsal claw.
Fig. 11. *Neoponera* (*Neoponera*) *villosa* (Fabricius), worker.
Fig. 12. *Euponera* (*Brachyponera*) *solitaria* (F. Smith), worker.

strongly convex above, masticatory border exceptionally long. Antennal scape slender, extending considerably beyond the posterior border of the head. Pronotum with a median tubercle and also a pair of lateral tubercles. Promesonotal suture distinct. Mesoepinotal suture represented by a prominent constriction. Epinotum usually with a pair of tubercles. Posterior coxa without a dorsal spine. Each middle and hind tibia with a single spur. Tarsal claw bifid. Petiole scalelike. Gaster with a strong constriction between the first and second segments. Head and thorax with mostly coarse, rugulose or rugulose-reticulate sculpturing; rugulae on first and second segments finer. One form, †*tuberculatum* (Olivier). This was imported from Guatemala in 1904 to control the cotton boll weevil, *Anthonomus grandis* Boh., in Victoria County, Tex. The experiments were not a success and the ants are thought to have become extinct. Nests in the soil. Predaceous, also carnivorous.

ECTATOMMA, subgenus PARECTATOMMA Emery

Ectatomma, subg. *Parectatomma* Emery, 1911, *in* Wytsman's Genera Insect., fasc. **118**:44.

Subgenotype, *Ectatomma* (*Gnamptogenys*) *triangulare* Mayr (by original designation).

Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:390.

Length approximately 3 mm. Eye placed slightly posterior to the middle of the side of the head. Clypeus short, rather convex, anterior border straight and entire in the middle. Mandible rather long, subtriangular; masticatory border longer than the superior border, not denticulate. Antennal scape reaching almost to the posterior corner of the head. A weak transverse impression between the pronotum and mesonotum but no suture. Base and declivity of epinotum subequal in length. Epinotum with a small protuberance on each side, which is neither dentate nor tuberculate. Petiole shorter than high, convex and rounded dorsally. Posterior coxa with a dorsal spine. Body for the most part longitudinally rugulose. One form, *hartmanni* Wheeler of Huntsville, Tex. Presumably native. Nothing known of its biology. Probably nests in the soil. Worker thought to be predaceous and carnivorous.

PROCERATIUM Roger

Pl. 2, Fig. 6

Proceratium Roger, 1863, Berlin. Ent. Ztschr. **7**:171.
Genotype, *Proceratium silaceum* Roger (monobasic).
Roger, 1860, Berlin. Ent. Ztschr. **4**:288.
Roger, 1863, Berlin. Ent. Ztschr. **7**:172.
Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:437.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:264, illus.
Emery, 1896, Soc. Ent. de France Bul., p. 101, illus.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:390.
Haskins, 1930, N. Y. Ent. Soc. Jour. **38**:121.
Kennedy, 1939, Ind. Acad. Sc. Proc. **48**:202, illus.

Length approximately 2-4 mm. Antenna 12-segmented, without a funicular club. Antennal scape narrow at base, much enlarged apically. Clypeus very short. Frontal carinae closely approximate anteriorly, more divergent posteriorly. Anterior border of clypeus not projecting in the middle. Eye extremely small, not easily discernible. Mandible subtriangular. Dorsal

sutures of thorax absent or obsolescent. Each middle and hind tibia with 1 spur. Tarsal claw simple. Petiole erect, scalelike. Epinotum often with a pair of lateral teeth or tubercles. Second gastric segment occupying a great deal of the gaster. Apex of gaster directed ventrally or anteroventrally. Five forms, †*crassicorne* Emery, †*crassicorne* var. *vestitum* Emery, †*croceum* (Roger), †*silaceum* Roger, *silaceum rugulosum* Wheeler. Members of the genus are apparently distributed over approximately the southeastern fourth of the United States. The ants nest by preference in well-rotted stumps and logs, especially those in a moist condition. Colonies small. For further information on biology see Haskins 1930.

SYSPHINCTA Roger

Pl. 2, Fig. 7

Sysphincta Roger, 1863, Berlin. Ent. Ztschr. **7**:175.
Genotype, *Sysphincta micrommata* Roger (monobasic).
Roger, 1860, Berlin. Ent. Ztschr. **4**:291.
Mayr, 1886, Zool.-Bot. Gesell. Wien. Verh. **36**:438.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:263, illus.
Emery, 1896, Soc. Ent. de France Bul., p. 101.

Length 4-4.25 mm. Antenna 12-segmented; funiculus without a club. Clypeus very short, its anterior border projecting in the middle. Eye extremely small, scarcely discernible. Frontal carinae closely approximate, each noticeably elevated and failing to cover most of the base of the antenna. Thorax without dorsal sutures. Posterior surface of epinotum with a thin carina or lamella on each side. Each middle and hind tibia with 1 spur. Tarsal claw simple. Petiole small, nodiform. First gastric segment separated from the second by an unusually strong constriction. Second gastric segment very large, occupying a great deal of the gaster. Apex of gaster directed ventrally or anteroventrally. Extremely rare. Two forms, *melina* (Roger), †*pergandei* Emery. *S. pergandei* is distributed over approximately the eastern half of the United States. It usually nests in the soil beneath stones, logs or other objects. The colonies are exceedingly small.

S. melina was described by Roger as *Ponera melina* from worker, female and male collected in "Carolina." No one since has succeeded in collecting or recognizing the species.

NEOPONERA, subgenus NEOPONERA Emery

Pl. 3, Fig. 11

Neoponera Emery, 1901, Soc. Ent. de Belg. Ann. **45**: 40, 43.
Subgenotype, *Formica villosa* Fabricius (by original designation).
*Emery, 1890, Soc. Ent. de France Ann. (6) **10**:74.
Emery, 1901, Soc. Ent. de Belg. Ann. **45**:47.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:403.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 235, illus.

Length 12-13 mm. Check with a prominent carina extending from the eye to the clypeus. Eye large, with numerous ommatidia, placed approximately at the middle or slightly anterior to the middle of the side of the head. Mandible large, subtriangular, strongly convex above, masticatory

border much longer than the superior border and bearing approximately 14 teeth. Clypeus convex in the middle, with a slight impression or emargination on the anterior border. Frontal carina with a well-developed lobe. Antennal scape stout, long, extending past posterior border of head. Pronotum marginate on each side. Promesonotal and mesoepinotal sutures distinct. Legs rather long. Middle and hind tibiae each with 2 spurs. Tarsal claws simple. Petiole unusually stout, in profile with approximately straight anterior surface and convex dorsal and posterior surfaces, the two surfaces fusing into each other without any perceptible demarcation; from behind, the upper half of the two combined surfaces appearing somewhat semicircular. Pile and pubescence golden or yellow. Uncommon. One form, †*villosa* (Fabricius) of southern Texas. Nests in the soil and also in logs and stumps. Predaceous, also carnivorous. Workers with a pronounced sting. Our largest species of ponerine ant.

PACHYCONDYLA, subgenus PACHYCONDYLA F. Smith

Pl. 2, Fig. 8

Pachycondyla F. Smith, 1858, Catalogue of Hymenopterous Insects in the Collection of the British Museum, pt. 6, p. 105.
Subgenotype, *Formica crassinoda* Latreille (by designation of Emery, 1901).
Fabricius, 1804, Syst. Piez., p. 401.
Emery, 1890, Soc. Ent. de France Ann. (6) **10**:71.
Wheeler, 1900, Biol. Bul. **2**:4, illus.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:401.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 234, illus.
Haskins and Enzmann, 1938, N. Y. Acad. Sci. Ann. **37**:150.

Length 7-8.5 mm. Eye moderately large, with numerous ommatidia; placed anterior to the middle of the side of the head. Frontal carina with well-developed lobe. Clypeus convex in the middle, the anterior border rounded. Antennal scape robust, not quite reaching the posterior corner of the head. Cheek without a longitudinal carina between the eye and the clypeus. Mandible subtriangular, convex above, masticatory border longer than the superior border and with approximately 10 teeth. Pronotum marginate on each side. Promesonotal suture distinct. Mesoepinotal suture usually absent or obsolescent. Base of epinotum and declivity meeting in a well-rounded, obtuse angle. Legs stout, middle and hind tibia each with 2 spurs. Tarsal claws simple. Petiole stout, though higher than long, broader than the epinotum, and also broader posteriorly than anteriorly; from above, the combined front and sides appearing more or less semicircular. One form, †*harpax* (Fabricius) of Texas and Louisiana. Nests usually constructed in the soil beneath stones and logs. Predaceous, also carnivorous. Wheeler, 1900, found individuals, similar to workers in size and structure, which laid and cared for eggs. *P. harpax,* however, has a normal female.

EUPONERA, subgenus BRACHYPONERA Emery

Pl. 3, Fig. 12

Euponera, subg. *Brachyponera* Emery, 1901, Soc. Ent. de Belg. Ann. **45**:43.
Subgenotype, *Ponera sennaarensis* Mayr (by original designation).
F. Smith, 1874, London Ent. Soc. Trans., p. 404.
Forel, 1900, Schweiz. Ent. Gesell. Mitt. **10**:267.

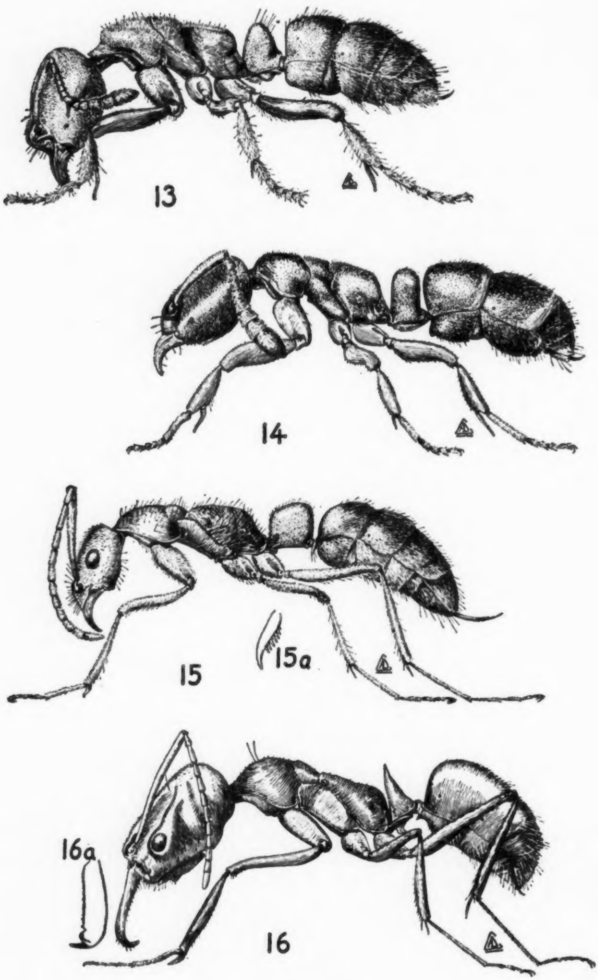


PLATE 4

Fig. 13. *Euponera (Trachymesopus) gilva* (Roger), worker.
Fig. 14. *Ponera coarctata pennsylvanica* Buckley, worker.
Fig. 15. *Leptogenys (Lobopelta) elongata* (Buckley), worker; fig. 15 a, tarsal claw.
Fig. 16. *Odontomachus haematoda desertorum* Wheeler, worker; fig. 16 a, left mandible.

Wheeler, 1906, Amer. Mus. Nat. Hist. Bul. **22**:306, illus.
Emery, 1909, Deut. Ent. Ztschr., p. 366, illus.
*Smith, 1934, Ent. Soc. Amer. Ann. **27**:557-564, illus.

Length 3.3-3.5 mm. Eye not large, with 9 or 10 ommatidia in its greatest diameter; placed about its greatest width from the base of mandible. Mandible rather large, subtriangular, masticatory border with at least 6 to 10 teeth. Antennal scape extending considerably beyond posterior border of head. Cheek without a longitudinal carina between eye and clypeus. Thorax stout. Mesonotum convex, appearing rather protuberant because of the distinct and deeply impressed sutures surrounding it. Epinotum, from above, narrower anteriorly than posteriorly, sides of declivity rather strongly margined. Most of meso- and metapleura smooth and shining. Middle and hind tibiae each with 2 spurs. Metatarsus of middle leg without stiff hairs or bristles on its extensor surface. Tarsal claws simple. Petiole higher than epinotum, also higher than long, shorter dorsally than ventrally. Body blackish or black with lighter mandibles, funiculi and legs. One form, †*solitaria* (F. Smith) which has been accidentally introduced into a number of towns in Georgia, North Carolina and Virginia. The small colonies nest in rotten logs and also in the soil beneath objects. Predaceous, also carnivorous. This ant is not known to be of any economic importance.

EUPONERA, subgenus TRACHYMESOPUS Emery

Pl. 4, Fig. 13

Euponera, subg. *Trachymesopus* Emery, 1911, *in* Wytsman's Genera Insect., fasc. 118, p. 84.
Subgenotype, *Formica stigma* Fabricius (by original designation).
Fabricius, 1804, Syst. Piez., p. 400.
Roger, 1863, Berlin. Ent. Ztschr. **7**:170.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:266, illus.
Wheeler and Gaige, 1920, Psyche **27**:69.
Smith, 1929, Ent. Soc. Amer. Ann. **22**:543.
Creighton and Tulloch, 1930, Psyche **37**:71, illus.
Haskins, 1931, N. Y. Ent. Soc. Jour. **39**:507.
*Smith, 1934, Ent. Soc. Amer. Ann. **27**:561.
*Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:824.

Length 3-4.75 mm. Eye extremely small, varying from an almost ocellus-like spot to an unusually small compound eye, with only a few ommatidia; placed in the anterior half of the side of the head, much more than its greatest diameter from the base of the mandible. Thorax short, stout. Mesonotum not surrounded by a deeply impressed suture or strongly protuberant. Middle and hind tibiae each with 2 spurs. Metatarsus of middle leg with strong bristles on its extensor surface. Tarsal claw simple. Sides of epinotum near base usually much compressed. Two forms, †*gilva* (Roger) of Florida, Alabama, Mississippi, Tennessee and Texas, and †*stigma* (Fabricius) of Florida. The former nests by preference in moist frass beneath the bark of pine log and stumps; the latter lives in logs and also in the soil beneath stones or other objects. Predaceous, also carnivorous. For further information on the biology of *gilva* see Haskins, 1931.

PONERA Latreille
Pl. 4, Fig. 14

Ponera Latreille, 1804, Nouv. Dict. Hist. Nat. **24**:179.
Genotype, *Formica coarctata* Latreille (by designation of Latreille, 1805).
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:171.
Mayr, 1887, Zool.-Bot. Gesell. Wien, Verh. **37**:536.
Forel, 1893, London Ent. Soc. Trans., pp. 363, 365-367.
Wheeler, 1900, Biol. Bul. **2**:44, illus.
Wheeler, 1903, Psyche **10**:94, illus.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:404-406.
Smith and Haug, 1931, Ent. Soc. Amer. Ann. **24**:507, illus.
*Smith, 1936, Ent. Soc. Amer. Ann. **29**:420.
Smith, 1939, Ent. Soc. Wash. Proc. **41**:76, illus.
Buren, 1944, Iowa State Col. Jour. Sci. **18**:279.

Length approximately 2-3.75 mm. Eye extremely small, often scarcely perceptible, consisting of one or several ommatidia; placed distinctly anterior to middle of the side of head. Funiculus very perceptibly enlarged toward the apex, the last 4 or 5 segments forming an indefinite club. Frontal carina with a well-developed lobe, which covers antennal insertion. Promesonotal and mesoepinotal sutures distinct. Mesonotum not surrounded by a deeply imprssed suture or strongly protuberant as in *Euponera,* subgenus *Brachyponera.* Legs short or moderately long, middle and hind tibiae each with a single spur. Metatarsus of middle leg without stiff bristles on its extensor surface. Tarsal claw simple. Petiole higher than long and often shorter dorsally than ventrally. Six forms, †*coarctata pennsylvanica* Buckley, †*ergatandria* Forel, †*inexorata* Wheeler, †*oblongiceps* M. R. Smith, †*opaciceps* Mayr, †*trigona* var. *opacior* Forel. More common in the southern half of the United States but one or more forms will probably be found in every state. The genus includes some of our smallest and most common ponerine ants. There are occasionally individuals in a colony that are intermediate between the worker and female. These wingless forms can be distinguished from the workers by their ocelli, larger eyes and differently shaped petiole. Ergatoid males occur in *ergatandria, oblongiceps, opaciceps* and *trigona* var. *opacior.* These worker-like males can be distinguished from workers by their genital appendages, different number of segments in the antenna, and differently shaped head and thorax. *P. coarctata pennsylvanica, opaciceps* and *trigona* var. *opacior* have normal males but no normal males are yet known for *ergatandria* and *oblongiceps.* The ants of this genus form small colonies which nest in rotten logs and stumps or in the soil beneath objects. Predaceous; also carnivorous.

LEPTOGENYS, subgenus LOBOPELTA Mayr
Pl. 4, Fig. 15

Lobopelta Mayr, 1862, Zool.-Bot. Gesell. Wien, Verh. **12**:733.
Subgenotype, *Ponera diminuta* F. Smith (by designation of Bingham, 1903).
Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:438.
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:172.
Wheeler, 1900, Biol. Bul. **2**:7, illus.
Wheeler, 1904, Biol. Bul. **6**:251, illus.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:406.

*Wheeler, 1923, Amer. Mus. Novitates No. 90: 14, 15.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 239, illus.

Length 5-6.5 mm. Middle of the anterior border of the clypeus extended as an acute point; a sharp median carina extending throughout the length of the clypeus. Eye large, prominent, with numerous ommatidia; located a little anterior to the middle of the side of the head. Antennal scape robust, unusually long, extending approximately one-third its length beyond the posterior corner of the head; funiculus slender, the second segment longer than any other segment. Frontal carinae short, rather closely approximate, each carina without a well-developed lobe, thus exposing most of the base of the antenna. Mandible slender, strongly curved dorsally, ending in a narrow toothless or almost toothless masticatory border. Thorax with well-developed promesonotal and mesoepinotal sutures. Base of epinotum very distinctly longer than the declivity. Legs long. Middle and hind tibiae each with a pair of spurs. Tarsal claw pectinate. Petiole, in profile, almost subrectangular except for its dorsal border which is higher posteriorly than anteriorly. Ventral surface of petiole and first gastric segment each with a prominent protuberance. Uncommon. Two forms, †*elongata* (Buckley) and its subspecies *manni* Wheeler. The former is confined to Texas, Louisiana and Florida; the latter was described from Florida. Nests are usually constructed in the soil. The ants feed largely on pill bugs, *Oniscus* spp. and *Armadallidium* spp. The female bears a striking resemblance to the worker but differs from this caste mainly in the more rounded epinotum, shorter and higher petiolar node, and larger gaster. The author has seen specimens of *elongata* labeled "Stone Mt., Decatur, Georgia." For biological information on *elongata* see Wheeler 1904.

ODONTOMACHUS Latreille

Pl. 4, Fig. 16

Odontomachus Latreille, 1804, Nouv. Dict. Hist. Nat. **24**:179.
Genotype, *Formica haematoda* Linnaeus (monobasic).
Guérin, 1844, Icon. Règne Anim. Ins. **7**:423.
Roger, 1861, Berlin. Ent. Ztschr. **5**:26.
Wheeler, 1900, Biol. Bul. **2**:1.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:407.
Wheeler, 1911, Harvard Univ. Mus. Compar. Zool. Bul. **54**:482.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:391.
*Smith, 1939, N. Y. Ent. Soc. Jour. **47**:125.
Haskins and Enzmann, 1938, N. Y. Acad. Sci. Ann. **37**:149.

Length 6-10 mm. Mandibles linear, articulated to the middle of the anterior border of the head in such a manner that when closed they lie subparallel to each other; inner border of each mandible with a row of denticulae, apex with 3 large teeth. Eye rather large, with numerous ommatidia; placed anterior to the middle of the side of the head. Head widest in the region of the eyes. Antenna slender, scape extending approximately to, or slightly beyond, posterior border of head. Head often with vestigial ocelli or ocellar pits. Each section of head with a groove which starts between eye and frontal carina and extends both posteriorly and mesially to converge above near vertex; another strong hollow or constriction posterior to the eye runs

obliquely from the ventral to the dorsal surface. Promesonotal suture well-developed. Mesoepinotal suture represented by a distinct constriction in this region. Base of epinotum distinctly longer than declivity. Petiole with a conical or spine-shaped elevation above. Middle and hind tibiae each with 2 spurs. Tarsal claw simple. Constriction between first and second gastric segments not pronounced. Thorax, not including most of mesopleura, covered with longitudinal or transverse rugulae, or both. Dorsal surface of head with very fine, dense, longitudinal rugulae. Four subspecies of *haematoda* (Linnaeus), namely, †*clarus* Roger in Texas and Louisiana, †*coninodis* Wheeler and †*desertorum* Wheeler in Arizona, and †insularis Guérin in Florida and Georgia. Nest in the soil and also in logs and stumps. Predaceous, also carnivorous. For information on biology see Wheeler 1900.

Subfamily Pseudomyrminae Emery

Pseudomyrminae Emery, 1899, Mem. R. Accad. Sc. Ist. Bologna (5) **8**:6.
Pseudomyrminae Wheeler, 1920, Psyche **27**:46.

Cloacal orifice ventral, slit-shaped. Pedicel consisting of 2 segments, the petiole and postpetiole. Sting well-developed. Body elongate, slender. Not antlike. Integument firm, highly sclerotized. Frontal carinae placed close to each other and not covering antennal insertions. Anterior border of clypeus with a median lobe, posterior border not extending back between frontal carinae. Eye remarkably large, occupying approximately half the length of side of head; reniform or subelliptical. Ocelli present. Antenna 12-segmented. Pronotum marginate or submarginate. Dorsum of thorax with distinct sutures. Epinotum unarmed. Middle and hind tibiae each with 2 spurs. Pupae naked. Colonies small, usually consisting of only a few hundred individuals. Arboreal. Nests constructed in plant cavities, insect galls, etc. Workers very fond of honeydew but no doubt also predaceous and carnivorous. Five forms. Distributed mostly south of the 35th degree of latitude but possibly extending farther north in the Mississippi Valley region. None is inimical to man's interest.

Pseudomyrma Guérin is the only genus in this subfamily.

PSEUDOMYRMA Guérin

Pl. 5, Fig. 17

Pseudomyrma Guérin, 1844, *in* Cuvier, Icon. Règne Anim. Ins., p. 427.
Genotype, *Formica gracilis* Fabricius (by designation of Wheeler, 1911).
F. Smith, 1855, London Ent. Soc. Trans. **3**:160.
F. Smith, 1858, Catalogue of Hymenopterous Insects in the Collection of the British Museum, pt. 6, p. 157.
Roger, 1863, Berlin. Ent. Ztschr. **7**:178.
Mayr, 1870, Sitz. Akad. Wiss. Wien, p. 408, 413.
F. Smith, 1877, London Ent. Soc. Trans., p. 63.
Emery, 1890, Soc. Ent. Ital. Bol. **22**:60, illus.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:269.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:83.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul: **24**:419-421.

Length 2.5-7.5 mm. Body extremely slender. Frontal carinae very closely approximated, not concealing the antennal insertions. Antenna 12-segmented, short, without a differentiated club. Middle of the anterior border of the clypeus with a lobe. Eye unusually large, reniform or subelliptical, occupying approximately one-half of the length of the side of the head. Ocelli present. Dorsum of thorax with distinct sutures. Pronotum marginate or submarginate. Epinotum unarmed. Petiole and postpetiole much broader posteriorly than anteriorly. Middle and hind tibiae each with 2 spurs. Five forms, †*brunnea* F. Smith, †*elongata* Mayr, †*flavidula* F. Smith, †*gracilis mexicana* Roger, †*pallida* F. Smith. These ants are distributed mainly south of the 35th degree of latitude from North Carolina to California. They may possibly extend farther north in the Mississippi Valley region. The small colonies are formed within cavities of plants. Arboreal. Workers very fond of honeydew but no doubt also predaceous and carnivorous.

Subfamily Myrmicinae Lepeletier

Myrmicites Lepeletier, 1836, Hist. Nat. Ins. Hymen. **1**:169.
Myrmicinae Dalla Torre, 1893, Catal. Hymen. **7**:53.

Cloacal orifice ventral, slit-shaped. Pedicel consisting of 2 segments, the petiole and postpetiole. Sting well-developed. Clypeus usually extended back between the frontal carinae. Frontal carinae usually well separated, each bearing a lobe which more or less conceals the antennal insertion. Integument firm, strongly sclerotized. Eye rarely vestigial or absent. Antenna composed of a variable number of segments ranging from 6 to 12, usually 12. Funiculus often with a club of from 1 to 5 segments. Body usually much sculptured, the sculpture often very characteristic in certain genera and species. Mesoepinotal region generally with a distinct to very pronounced impression or constriction. Epinotum seldom bare, more commonly with a single pair of spines, these sometimes represented by a pair of small tubercles. Monomorphic, dimorphic or polymorphic. Pupae naked. One of our most diverse groups of ants with respect to size, shape, structure and habits. Colonies, according to form, may contain from a few dozen individuals to many thousands. Nests are constructed in the soil, in wood, crevices in trees and plants, plant debris, insect galls, buildings, ships and other protected places. Feeding habits are especially diverse and include such substances as fungi, plants or plant products, flesh of animals, honeydew, human eatables, etc. Some forms have restricted diets, others are general feeders. This is the largest and most common subfamily with 385 forms. Although representatives occur in every state, myrmicine ants are much more abundant in the southern section of the country than in northern areas. The subfamily also contains more forms inimical to man's interest than any other group. The ants may affect man by causing annoyance through their nesting habits, by biting and stinging, by feeding on plants or plant products, by gnawing into cloth, woolens and linen, and removing rubber insulation from telephone wires, by acting as intermediate hosts for animal parasites, and even by carrying dysentery germs on their bodies.

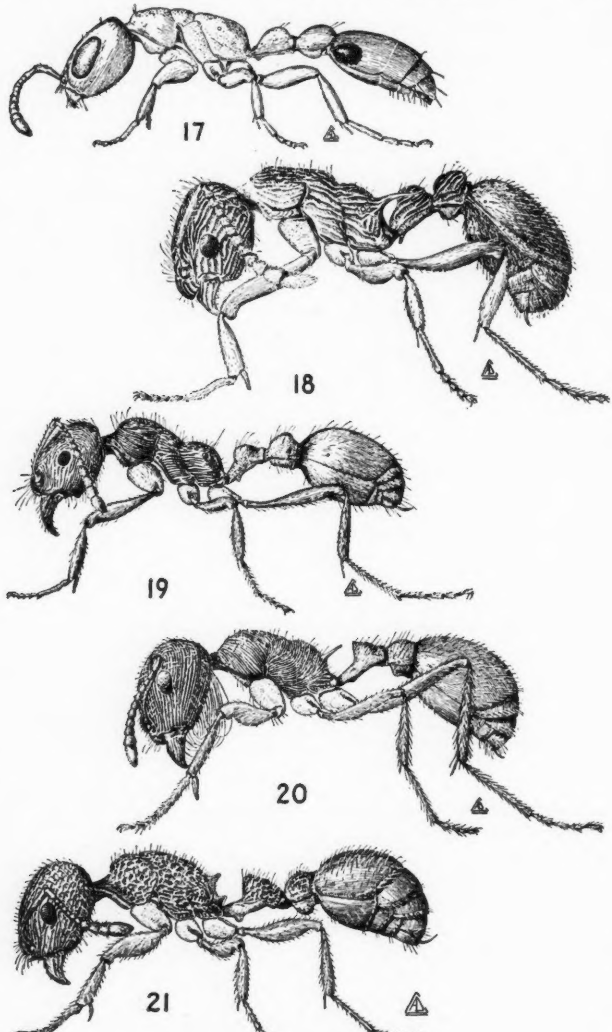


PLATE 5

Fig. 17. *Pseudomyrma flavidula* F. Smith, worker.
Fig. 18. *Myrmica (Myrmica) punctiventris* Roger, worker.
Fig. 19. *Myrmica (Manica) mutica* Emery, worker.
Fig. 20. *Pogonomyrmex (Pogonomyrmex) occidentalis* (Cresson), worker.
Fig. 21. *Pogonomyrmex (Ephebomyrmex) imberbiculus* Wheeler, worker.

1. Workers either extremely rare or absent, strictly inquilinous or parasitic forms 2
Workers always present, free-living forms with a few exceptions 3

2. (1) Workers extremely rare. (One form, *inquilina* Wheeler, which is parasitic in colonies of *Pheidole pilifera* (Roger) and its subspecies *coloradensis* Emery. Nebraska and Colorado. Extremely rare.) Pl. 7, fig. 27 .... *Epipheidole* Wheeler, p. 560

Workers absent.

a. Base of gaster of female with a prominent impression or furrow dorsally .... b

Base of gaster of female without a prominent impression or furrow dorsally. (A single parasitic form, *elecebra* Wheeler, which has been found in colonies of *Pheidole ceres* Wheeler in Colorado. Only soldiers and workers of the host ant are known to occur in parasitized colonies.) .... *Sympheidole* Wheeler, p. 561

b. Base of gaster of female with a broad impression dorsally. Epinotum unarmed. A single form, *pergandei* Emery, found on only one occasion in a nest of *Monomorium minimum* (Buckley) at Washington, District of Columbia. Pl. 10, fig. 37 .... *Epoecus* Emery, p. 569

Gaster of female with a longitudinal furrow dorsally. Epinotum bituberculate. Parasitic in colonies of the introduced pavement ant, *Tetramorium caespitum* (Linnaeus). Extremely rare. Found on one occasion each in New Jersey, Connecticut, Delaware and Virginia. Parasitized colonies of the host are always devoid of all castes except workers. Pl. 10, fig. 38 .... *Anergates* Forel, p. 571

3 (1) Antenna with 6 segments. (Last segment of antenna approximately as long as, or longer than, the combined lengths of the remaining funicular segments. Body hairs of diverse shape, usually clavate or spatulate. Petiole and postpetiole usually with spongiform processes. Rare.) Pl. 14, fig. 53 .... *Strumigenys* F. Smith

a. Mandible slender, porrect, subparallel, longer than one-half the length of the head; apex with 2 prominent teeth. Pl. 14, fig. 53 .... *Strumigenys*, subg. *Strumigenys* F. Smith, p. 585

Mandible of diverse shape but never as described above. Pl. 14, fig. 54 .... *Strumigenys*, subg. *Trichoscapa* Emery, p. 585

Antenna with more than 6 segments 4

4. (3) Antenna with 10 segments. (The last 2 segments of the funiculus forming a very distinct club. Clypeus bicarinate. Epinotum unarmed.) Pl. 9, fig. 34 .... *Solenopsis* Westwood

a. Polymorphic. (Length 1.6-6 mm. Eye well-developed, never with less than 20 ommatidia and usually with 30 or more.) Pl. 9, fig. 34 .... *Solenopsis*, subg. *Solenopsis* Westwood, p. 566

Monomorphic or feebly polymorphic .... b

b. Eye very small, with 15 ommatidia or less, often not more than 2 or 3. Monomorphic. (Largest subgenus with the most widely distributed forms.) Pl. 9, fig. 36 .... *Solenopsis*, subg. *Diplorhoptrum* Mayr, p. 569

Eye larger with 18-22 ommatidia. Monomorphic or feebly polymorphic (*globularia littoralis* Creighton can be recognized by the unusually large, subglobular postpetiolar node.) Pl. 9, fig. 35 .... *Solenopsis* subg. *Euophthalma* Creighton, p. 567

Antenna with more than 10 segments 5

5. (4) Antenna with 11 segments 6
Antenna with 12 segments 18

6. (5) Postpetiole attached to dorsal surface of the base of the gaster. Gaster subcordate, more convex ventrally than dorsally and with an acute apex .... *Crematogaster* Lund

a. Antennal club 3-segmented. Postpetiole with an impression or longitudinal furrow dividing it into 2 more or less distinct lobes. (Petiole very distinctly

broader anteriorly than posteriorly.) Pl. 8, fig. 30 ....*Crematogaster*, subg. *Acrocoelia* Mayr, p. 563

Antennal club 2-segmented. Postpetiole without an impression or longitudinal furrow. Pl. 7, fig. 29 ....*Crematogaster*, subg. *Orthocrema* Santschi, p. 562

Postpetiole attached to basal surface of gaster. Gaster not as above 7

7.(6) Body much flattened. Frontal carinae distant, continuing backward above eyes on the side of the head, each forming a prominent, more or less horizontal lobe under which the antenna can be concealed. Thorax more or less marginate. Thorax, petiole and postpetiole with irregular spines or tubercles. Hairs short, silvery or grayish, closely appressed to body. Dimorphic. Soldier with a prominent, saucer-shaped concavity on the dorsal surface of the head. Florida, Texas and Arizona ....*Cryptocerus* Fabricius

a. Saucer-shaped concavity on head of soldier with the rim broken or interrupted anteriorly and very poorly formed posteriorly. Arizona and Texas. Pl. 14, fig. 51 ....*Cryptocerus*, subg. *Cryptocerus* Fabricius, p. 583

Saucer-shaped concavity on head of soldier completely rimmed, the concavity deep within. (Mandibles concealed from above. Gaster elongate.) Florida. Pl. 14, fig. 52 ....*Cryptocerus*, subg. *Cyathomyrmex* Creighton, p. 583

Body not flattened, and otherwise not the above combination of characters 8

8. (7) Scape stout, strongly flattened, lacking a great deal of reaching the posterior border of the head; last 4 funicular segments enlarged but not forming a well-defined club. Frontal carina approximately as long as the antennal scape and forming a scrobe for the reception of the scape. Anterior border of clypeus with a very distinct median emargination. Clypeus not elevated as a carina in front of the antennal socket. Slave-making forms with members of *Leptothorax* as slaves. Pl. 12, fig. 46 ....*Harpagoxenus* Forel, p. 578

Not agreeing entirely with the above characterization 9

9. (8) Eye very coarsely faceted, with the border nearest the mandible forming a rather acute point which is directed anteroventrally. Frontal carina extending almost to the posterior border of the head and forming a more or less distinct scrobe for the reception of the scape. Prothorax with angular humeri. Petiolar node, in profile, subrectangular. Length approximately 1.5 mm. Florida. Pl. 13, fig. 50 ....*Wasmannia* Forel, p. 582

Differing in one or more characters 10

10. (9) Region between mandible and inner border of eye with a longitudinal carina which extends either posteriorly or postero-mesially 11

Region between mandible and inner border of eye without a longitudinal carina 14

11.(10) Mesonotum with from 1 to 2 pairs of spines which are either bare or else covered with tubercles. Monomorphic to polymorphic. Length 1.5-12 mm. 12

Mesonotum without spines as described above, at best with either blunt tubercles or blunt carinae. Monomorphic. Length 1.8-2.5 mm. ....*Cyphomyrmex* Mayr

a. Body above apparently without erect hairs (hairs short, very closely appressed, scale-like). Lobe over antennal scape not forming a rather acute, anterolateral angle. Protuberance on humeral angle of prothorax not spiniform. Pl. 15, fig. 55 ....*Cyphomyrmex*, subg. *Cyphomyrmex* Mayr, p. 587

Dorsal surface of head, at least, with erect hairs. Lobe over antennal scape forming a rather acute, anterolateral angle. Protuberance on humeral angle of prothorax distinctly spiniform. Pl. 15, fig. 56 ....*Cyphomyrmex*, subg. *Mycetosoritis* Wheeler, p. 588

12.(11) Thoracic dorsum with 3 pairs of acute spines. Polymorphic. Length 1.5-12 mm. (A single form, *texana* Buckley of Texas and western Louisiana.) Pl. 15, fig. 58 ....*Atta* Fabricius, p. 591

Thoracic dorsum with more than 3 pairs of spines which may be of diverse shapes 13

13.(12) Frontal carinae distinct, extended almost to the posterior border of the head. Lobe covering antennal insertion without a pair of spines or a pair of tubercles. Head not strongly widened behind nor with a deeply emarginate posterior border. Monomorphic. Length 2.5-4 mm. Pl. 16, fig. 59 .... *Trachymyrmex* Forel, p. 588

Frontal carinae rather indistinct, and not extended almost to the posterior border of the head. Lobe covering the antennal insertion with a pair of spines or a pair of tubercles. Head (in largest workers, at least) greatly widened behind and with a deeply emarginate posterior border, giving it a subcordate appearance. Polymorphic. Length 2.3-6 mm., *versicolor* (Pergande) of Arizona and its subspecies *chisosensis* Wheeler of Texas. Pl. 15, fig. 57 .... *Acromyrmex*, subg. *Moellerius* Forel, p. 589

14.(10). Clypeus elevated in the form of a carina in front of each antennal socket. (Frontal carina extended approximately to the posterior border of the head and forming a more or less distinct scrobe for the reception of the flat antennal scape. Metasternum with a pair of distinct angles or spines. Arid regions of Texas and Arizona.) Pl. 13, fig. 49 .... *Xiphomyrmex* Forel, p. 582

Clypeus not elevated in the form of a carina in front of each antennal socket 15

15.(14) Antennal club prominent, 2-segmented, longer than the remainder of the funiculus. (Eye extremely small. Postpetiole, from above, subcampanulate. One form, *longii* Wheeler of Texas.) Pl. 11, fig. 39 .... *Erebomyrmex* Wheeler, p. 571

Antennal club not as above 16

16.(15) Epinotum unarmed. Integument smooth or very weakly sculptured. (Length 1.7 mm. Florida. Petiole not pedunculate. Middle of the anterior border of the clypeus with a bidentate lobe.) Pl. 8, fig. 33 .... *Xenomyrmex* Forel, p. 566

Epinotum armed. Part of the integument, at least, with well-developed sculpture 17

17.(16) Inquilinous in the nest of *Myrmica mutica* Emery. (Utah. Ocelli often present. Clypeus large, convex, longitudinally impressed in the middle, with entire, rounded anterior border. Body, antennae and legs with abundant, coarse, suberect hairs which are often frayed at the ends. Rare.) .... *Symmyrmica* Wheeler, p. 578

Mostly free-living forms; if inquilinous, then not occurring in the nest of *Myrmica mutica* Emery .... *Leptothorax* Mayr

a. Petiole and postpetiole armed with spines or tubercle-like protuberances. Prothorax with very distinct humeral angles. (Body hairs obtuse or clavate. One form, *wilda* M. R. Smith of extreme southern Texas.) Pl. 11, fig. 42 .... *Leptothorax*, subg. *Goniothorax* Emery, part, p. 575

Petiole and postpetiole unarmed. Prothorax seldom with humeral angles; if with angles, then the angles are not sharply produced as in the subgenus *Goniothorax* .... b

b. Mesoepinotal constriction usually distinct or pronounced. Prothorax without angular humeri. (Petiole not strongly pedunculate. Epinotum usually with short, blunt spines. Hairs on body usually obtuse or clavate.) Pl. 12, fig. 45 .... *Leptothorax*, subg. *Mychothorax* Ruzsky, p. 577

Mesoepinotal constriction usually absent, if present, scarcely perceptible. Prothorax occasionally subangular. Pl. 12, fig. 43 .... *Leptothorax*, subg. *Leptothorax* Mayr, part, p. 575

18. (5) Epinotum with 2 pairs of spines (exclusive of the pair of spines or angles that often occur on the metasternum of some ants). Petioles not pedunculate. Frontal carina not forming a scrobe for the reception of the antennal scape. Hairs simple. Legs short, with incrassated femora and tibiae. Native forms. Pl. 11, fig. 40 .... *Myrmecina* Curtis, p. 573

Differing in one or more characters from the above 19

19.(18) Clypeus elevated in the form of a carina or ridge in front of the antennal socket. Introduced forms usually found in greenhouses or in urban districts 20

Clypeus otherwise. Native forms. If clypeus appears somewhat similar to that described above, then the spurs of each middle and hind tibia are pectinate, the mesoepinotal constriction on the dorsal surface of the thorax is usually absent or obsolescent, and the ventral surface of the head may bear a psammophore 21

20.(19) Body covered with dense, soft, erect hairs which are branched or trifid. Thorax strongly arched dorsally and without promesonotal and mesoepinotal sutures. A single introduced form, *striatidens* Emery, which has been found in a few towns in the Southern States. Pl. 13, fig. 47 ....*Triglyphothrix* Forel, p. 579

Body hairs simple. Thorax not strongly arched. Introduced forms, most common in restricted localities in the Southern States or the states bordering the Atlantic Ocean and Gulf of Mexico. Pl. 13, fig. 48 ....*Tetramorium* Mayr, p. 581

21.(19) Spurs of each middle and hind tibia very distinctly pectinate 22

Spurs of each middle and hind tibia simple or absent 23

22.(21) Mesoepinotal constriction usually obsolescent or absent. Anterior border of the clypeus often with a pair of teeth, mesad of which there may or may not be a distinct emargination. Ventral surface of head usually with a psammophore. (Forms occurring mostly west of the 95th degree of longitude.) Pl. 5, fig. 20 ....*Pogonomyrmex* Mayr

a. Small forms, length 3.5-4.8 mm. Ventral surface of head without a psammophore. Body very roughly sculptured. Hairs on dorsal surface rather short. Oklahoma, Texas, New Mexico and Arizona. Pl. 5, fig. 21 ....*Pogonomyrmex*, subg. *Ephebomyrmex* Wheeler, p. 553

Large forms, length 4.5-10 mm. Ventral surface of head with a psammophore. Sculpture diverse but usually not so coarse as that of *Ephebomyrmex*. Hairs usually longer. (Anterior border of clypeus with a faint to distinct emargination, on each side of which there is an angle or a tooth.) Pl. 5, fig. 20 ....*Pogonomyrmex*, subg. *Pogonomyrmex* Mayr, p. 552

Mesoepinotal constriction pronounced. Anterior border of clypeus not as described. Ventral surface of head without a psammophore. (Antennal scape often with a lobe or keel at the base.) ....*Myrmica* Latreillle

a. Epinotum either unarmed or else with a pair of extreemly short, blunt protuberances. Last 5 segments of the funiculus enlarged to form a more or less distinct club. Apparently distributed in the mountainous areas west of the 105th degree of longitude. Pl. 5, fig. 19 ....*Myrmica*, subg. *Manica* Jurine, p. 551

Epinotum with a pair of spines. Last 3 or 4 segments of the funiculus enlarged to form a club. Distributed over the entire United States but apparently uncommon or absent in the extreme South. (Head and thorax usually with coarse, longitudinal rugulae.) Pl. 5, fig. 18 ....*Myrmica*, subg. *Myrmica* Latreille, p. 550

23.(21) Epinotum unarmed. (Antennal club 3-segmented. Clypeus usually with a pair of longitudinal carinae which are extended on the anterior border as more or less distinct teeth. If the clypeal teeth and carinae are obsolescent or absent then the ants are somewhat dimorphic and the posterior border of the head and epinotum are transversely rugulose.) Pl. 8, fig. 31 ....*Monomorium* Mayr

a. Antennal club with the first 2 segments subequal. Clypeal teeth and carinae obsolescent or absent. Posterior border of head and epinotum with transverse rugulae. Workers variable in size with a tendency to dimorphism. (A single introduced form, *destructor* (Jerdon) which has been introduced into several localities in Florida and Tennessee.) Pl. 8, fig. 32 ....*Monomorium*, subg. *Parholcomyrmex*, p. 566

Antennal club not as described. Clypeus with a pair of longitudinal carinae which are extended on the anterior border as more or less distinct teeth. Posterior border of head and epinotum without transverse rugulae. Workers monomorphic. Pl. 8, fig. 31 ......*Monomorium*, subg. *Monomorium* Mayr, p. 565

Epinotum usually armed (if the epinotum is unarmed or appears to be unarmed then the ant lacks one or more of the characters given in the alternative) 24

24.(23) In profile, clypeus strongly projecting above mandibles. Petiole very distinctly pedunculate. Each middle and hind tibia without spurs. Body clothed with closely appressed pubescence. Erect hairs almost, if not entirely absent from the dorsal surface of body except on the clypeus, mandibles and apex of gaster. Monomorphic. Small (1.6-2.5 mm.), apparently introduced forms recorded from a number of localities in Florida. Pl. 7, fig. 28 ....*Cardiocondyla* Emery, p. 561

Differing in one or more characters 25

25.(24) Petiole (also postpetiole) armed with spines or tubercle-like protuberances. (Prothorax with very distinct humeral angles. Body hairs obtuse or clavate.) Pl. 11, fig. 42 ....*Leptothorax*, subg. *Coniothorax* Emery, part, p. 575

Petiole without spines or tubercle-like protuberances 26

26.(25) Antenna without a 3-segmented club (in this case there are more than 3 segments in the club or else no definite club is indicated) 27

Antenna with a distinct 3-segmented club 30

27.(26) Clypeus with a pair of longitudinal carinae. Petiole distinctly pedunculate. Eye variable, usually ranging from vestigial to small. Last 4 segments of the funiculus enlarged but not forming a clearly defined club. Small, slender ants 2.4-4 mm. Pl. 6, fig. 22 ....*Stenamma* Westwood, p. 553

Differing in one or more characters from the above 28

28.(27) Legs and antennae extremely long. Large ants (6-8.5 mm.) with a slender body. Hairs coarse, grayish. Epinotum not clearly set apart from the mesonotum by a well-defined suture, but often this region is marked by a broad impression. Arid regions of Texas, New Mexico and Arizona. Pl. 6, fig. 24 ....*Novomessor* Emery, p. 556

Without all of the above-mentioned characters 29

29.(28) Head subrectangular to subquadrate. Mesoepinotal region with an impression varying from moderately broad to broad. Body ordinarily not slender. Legs and antenna also not particularly slender or long. Middle of anterior border of clypeus in some species with a tooth or even a longitudinal groove. Psammophore occasionally present. Colorado, Nevada, Arizona and California. Pl. 6, fig. 25 ....*Veromessor* Forel, p. 557

Head usually not subrectangular or subquadrate. Epinotum usually set apart from the mesonotum by a distinct suture; if there is an impression it is not very broad or deep. Body usually slender, with rather long legs and antennae. Anterior border of clypeus emarginate but without a longitudinal groove or a tooth. Psammophore absent. One or more forms present in every state. Pl. 6, fig. 23 ....*Aphaenogaster*, subg. *Attomyrma* Emery, p. 555

30.(26) Mesoepinotal impression on dorsal surface of thorax obsolescent or absent 31

Mesoepinotal impression on dorsal surface of thorax distinct, pronounced 32

31.(30) Thorax short, longitudinally arched. Promesonotal and mesoepinotal sutures faintly indicated or absent. Femora incrassated, those of the posterior pair of legs very noticeably so. Epinotal spines prominent. Postpetiole not constricted posteriorly. Florida, Texas, Louisiana and Arizona. Uncommon. Pl. 11, fig. 41 ....*Macromischa* Roger, p. 575

Differing from the above in one or more characters. Common. Pl. 12, fig. 43........ ....*Leptothorax*, subg. *Leptothorax* Mayr, part, p. 575

32.(30) Dimorphic forms (a few forms polymorphic), the soldier with an abnormally large head. The head may be subrectangular, subquadrate, subcordate, or of different shape, but is usually characterized by a prominent, emarginate posterior border which forms 2 more or less pronounced occipital lobes. Often there is also a very distinct frontal groove. A very large genus with one or more forms present in every state. Pl. 7, fig. 26 ....*Pheidole* Westwood, p. 557

Monomorphic forms which lack the abnormally large-headed soldier. Present known distribution, Maryland, and Florida westward into Nebraska and Texas. Pl. 12, fig. 44 ....*Leptothorax*, subg. *Dichothorax* Emery, p. 576

MYRMICA, subgenus MYRMICA Latreille

Pl. 5, Fig. 18

Myrmica Latreille, 1804, Nouv. Dict. Hist. Nat. **24**:179.

Subgenotype, *Formica rubra* Linnaeus (by designation of Latreille, 1810).

Nylander, 1846, Act. Soc. Sc. Fennicae **2**:927, illus.

Meinert, 1861, Naturf. Afd. Dansk. Vid. Selsk. (5 R.) **5**:273.

Roger, 1863, Berlin. Ent. Ztschr. **7**:190.

Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:312.

Forel, 1904, Soc. Ent. Belg. Ann. **48**:154.

Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:384.

Wheeler, 1906, Psyche **13**:38.

Wheeler, 1907, Wis. Nat. Hist. Soc. Bul. **5**:73-78.

Emery, 1908, Deut. Ent. Ztschr., p. 176, illus.

Wheeler, 1908, Jour. Econ. Ent. **1**:337.

Forel, 1914, Deut. Ent. Ztschr., p. 617.

Wheeler, 1914, N. Y. Ent. Soc. Jour. **22**:52.

Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:502-506.

Forel, 1922, Suisse Zool. Rev. **30**:92.

Smith, 1930, Ent. Soc. Amer. Ann. **23**:566, illus.

Weber, 1939, Lloydia **2**:144.

Donisthorpe, 1927, British Ants, Geo. Routledge and Sons, London, 2d ed., pp. 118-123, illus.

*Buren, 1944, Iowa State Col. Jour. Sci. **18**:281.

Length 3-6.2 mm. Head usually longer than broad, with rounded posterior corners. Antenna 12-segmented; scape usually curved or bent at the base and often bearing a prominent lobe or keel; last 3 or 4 segments of the funiculus forming a club, the last 3 segments of this club shorter than the remainder of the funiculus. Eye convex, prominent, placed near the middle or slightly anterior to the middle of the side of the head. Frontal carina short, usually with a lobe which sometimes conceals most of the antennal insertion. Clypeus convex, anterior border often emarginate. No psammophore beneath the head. Promesonotal suture often obsolescent. Thorax with a constriction in the mesoepinotal region which is usually well-defined. Epinotum armed with a pair of spines, which are highly variable in size and shape. Spurs pectinate. Petiole usually rather weakly pedunculate, generally with a distinct anteroventral tooth or spine. Gaster oval, armed with a sting. Sculpturing of head and thorax often coarse, largely of a rugulose or rugulose reticulate nature. Twenty-seven forms, one or more occurring in every State. More common in the northern half of the United States, uncommon or absent in the extreme southern parts. The forms are †*brevinodis* Emery, *brevinodis*

var. *brevispinosa* Wheeler, †*brevinodis* var. *canadensis* Wheeler, *brevinodis* var. *decedens* Wheeler, *brevinodis discontinua* Weber, †*brevinodis* var. *subalpina* Wheeler, †*brevinodis* var. *sulcinodoides* Emery, †*laevinodis* Nylander, *laevinodis* var. *bruesi* Wheeler, †*mexicana* Wheeler, †*punctiventris* Roger, *punctiventris* var. *isfahani* Forel, *punctiventris pinetorum* Wheeler, †*scabrinodis* var. *detrinodis* Emery, †*scabrinodis* var. *fracticornis* Emery, †*scabrinodis* var. *glacialis* Forel, †*scabrinodis sabuleti* Meinert, †*scabrinodis sabuleti americana* Weber, *scabrinodis sabuleti hamulata* Weber, *scabrinodis sabuleti nearctica* Weber, *scabrinodis schencki* Emery, *scabrinodis schencki emeryana* Forel, *scabrinodis schencki monticola* Wheeler, †*scabrinodis schencki spatulata* M. R. Smith, †*scabrinodis schencki tahoensis* Wheeler, †*scabrinodis schencki trullicornis* Buren, *wheeleri* Weber. The moderate-sized colonies usually nest in the soil. The workers commonly attend honeydew-excreting insects but are also carnivorous. No group of ants is more badly in need of revision than the subgenus *Myrmica*.

Forel's *laevinodis neolaevinodis* is not listed above because there is some doubt that his type specimens came from the United States.

MYRMICA, subgenus MANICA Jurine

Pl. 5, Fig. 19

Manica Jurine, 1807, Nouvelle Méthode de Classer les Hyménoptéres et les Diptéres, p. 276.
Subgenotype, *Formica rubida* Latreille (by designation of Wheeler, 1911).
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:311-312.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:77.
*Wheeler, 1914, Psyche **21**:118, illus.
Wheeler, 1915, Psyche **22**:50.
Creighton, 1934, Psyche **41**:185.

Length 4-6 mm. Head subrectangular, varying from slightly longer than broad to approximately as broad as long. Eye prominent, placed near the middle of the side of the head. Antennal fossa prominent. Antenna 12-segmented; scape curved at base, without a lobe, last 5 segments of funiculus enlarged but not forming a very well developed club. Mandible large, subtriangular, with 2 large apical teeth and 12-14 smaller teeth. Frontal carinae short, spaced well apart, subparallel. Promesonotal suture poorly defined or absent, mesoepinotal constriction usually broad and deep. Epinotum unarmed. Legs long. Femora somewhat incrassated toward their apices. Spurs pectinate. Petiole with a small ventral tooth. Postpetiole of some species with a pointed or rounded protuberance beneath. Gaster oval, not truncate basally, with well-developed sting. Head and thorax largely rugulose. Five forms, †*aldrichi* Wheeler, †*bradleyi* Wheeler, †*hunteri* Wheeler, †*mutica* Emery, and †*parasitica* Creighton. One or more of these occur in the mountainous areas of those states west of the 105th degree of longitude. The most common is *mutica*. According to Wheeler 1914, p. 118, this form "usually nests in sandy creek bottoms under stones or in small crater nests." The workers can sting severely. *Symmyrmica chamberlini* Wheeler is inquilinous in the nests of *mutica*. *M. (M.) parasitica,* which is known only from workers, is parasitic in colonies of *bradleyi*.

POGONOMYRMEX, subgenus POGONOMYRMEX Mayr

Pl. 5, Fig. 20

Pogonomyrmex Mayr, 1868, Soc. dei Nat. di Modena Ann. **3**:169.
Subgenotype, *Formica badia* Latreille (by designation of Wheeler, 1911).
Pergande, 1893, Calif. Acad. Sci. Proc. (2) **4**:33.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:308.
*Wheeler, 1902, Amer. Nat. **36**:85, illus.
*Wheeler, 1902, Psyche **9**:387.
Wheeler, 1914, Psyche **21**:149.
Forel, 1914, Soc. Vaud. des Sci. Nat. Bul. **50**:269.
Smith, 1929, Ent. Soc. Amer. Ann. **22**:546.
*Olsen, 1934, Harvard Univ. Mus. Compar. Zool. Bul. **77**:493-514, illus.
Cole, 1936, Ent. News **47**:120.
Cole, 1938, Amer. Midl. Nat. **19**:240-241.

Length 4.5-10 mm. Head subrectangular or subquadrate, broad in proportion to its length. Eye prominent, often placed nearer to the posterior border than the anterior border of the head. Antenna 12-segmented; last 4 funicular segments enlarged but not forming a well-defined club. Mandible with distinct teeth (sometimes edentate in the largest workers of *badius*). Anterior border of clypeus with a shallow to deep margination on each side of which there is a more or less distinct tooth or angle. Ventral surface of head and mandible with psammophore. Mesoepinotal constriction on thorax vestigal or absent. Promesonotal and mesoepinotal sutures usually obsolescent or absent. Epinotum usually with a pair of spines, the spines vestigal or absent in a few forms. Petiole usually distinctly pedunculate. Spurs pectinate. Gaster oval, without truncate base, with a well-developed sting capable of inflicting a painful wound. Head and thorax usually with numerous rugulae, which are often interspersed with fine to coarse punctuations. Hairs coarse, light yellowish or grayish. *P. badius* has polymorphic workers, the largest of which have enormous heads. The thorax of the large worker also has more than the usual number of sclerites. Twenty-eight forms, †*apache* Wheeler, †*badius* (Latreille), *barbatus* (F. Smith), †*barbatus curvispinosus* Cole, †*barbatus* var. *fuscatus* Emery, †*barbatus* var. *marfensis* Wheeler, †*barbatus* var. *molefaciens* (Buckley), †*barbatus* var. *nigrescens* Wheeler, †*barbatus rugosus* Emery, †*californicus* (Buckley), †*californicus barnesi* M. R. Smith †*californicus estebanius* Pergande, *californicus* var. *hindleyi* Forel, †*californicus longinodis* Emery, †*californicus maricopa* Wheeler, †*comanche* Wheeler, †*desertorum* Wheeler, *desertorum* var. *ferrugineus* Olsen, *desertorum* var. *tenuispina* Forel, †*huachucanus* Wheeler, †*occidentalis* (Cresson), *occidentalis owyheei* Cole, †*occidentalis* var. *utahensis* Olsen, *salinus* Olsen, †*sancti-hyacinthi* Wheeler, *similis* Olsen, †*subdentatus* Mayr, †*subnitidus* Emery. Most of the forms occur west of the 95th degree of longitude, the group being most common in the Southwest. A single form, *badius*, is found in the states bordering the Gulf of Mexico and the Atlantic Ocean from Louisiana to New Jersey. The ants of this subgenus form large colonies in the soil, often constructing characteristic mounds of notable size. Some of the forms are of considerable economic importance because of their painful sting, the stealing of seeds from seed beds, and occupation of large tracts of land by their nesting and foraging activities.

POGONOMYRMEX, subgenus EPHEBOMYRMEX Wheeler

Pl. 5, Fig. 21

Pogonomyrmex, subg. *Ephebomyrmex* Wheeler, 1902, Psyche **9**:390.
Subgenotype, *Pogonomyrmex naegelii* Forel (by designation of Wheeler, 1911).
*Wheeler, 1902, Amer. Nat. **36**:85, illus.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:79.
*Olsen, 1934, Harvard Univ. Mus. Compar. Zool. Bul. **77**:493, illus.

Approximately monomorphic. Length 3.5-4.8 mm. Head almost as broad as long. Antenna 12-segmented; last 4 funicular segments enlarged but not forming a well-defined club. Clypeus on each side projecting forward in front of antennal fossa as a weak to usually prominent tooth or lobe. Hairs beneath head although often long, not arranged in a psammophore as with the subgenus *Pogonomyrmex*. Thorax short, arched anteroposteriorly. Promesonotal and mesoepinotal sutures obsolescent or absent. Epinotum with a pair of short spines which are usually connected by a transverse ridge or carina. Metasternum extended posteriorly as a pair of short spines or tubercles. Femora rather incrassated. Spurs pectinate. Gaster oval, not truncate at the base, provided with a sting. Head, thorax and petiole rather coarsely sculptured, especially the thorax, where the sculpturing is more irregular and of a rugose reticulate nature. Hairs on dorsal surface of body rather short, usually much shorter than with the subgenus *Pogonomyrmex*. Three forms, †*imberbiculus* Wheeler of Texas, Oklahoma, and New Mexico, †*pima* Wheeler of Arizona, and *townsendi* Wheeler of Arizona and Mexico. The ants form small colonies in the soil. Wheeler found that *imberbiculus* nests beneath stones. The workers seem to lack the aggressive disposition of those of the subgenus *Pogonomyrmex*. Very little is known about the biology of members of this group.

STENAMMA Westwood

Pl. 6, Fig. 22

Stenamma Westwood, 1840, An Introduction to the Modern Classification of Insects, Suppl., **2**:83.
Genotype, *Stenamma westwoodi* (Stephens, ms.) Westwood (monobasic).
Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:447, 454.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:298.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:347.
*Wheeler, 1903, Psyche **10**:164.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:410.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:520.
Smith, 1930, Ent. Soc. Amer. Ann. **23**:564, illus.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:284.

Slender ants. Length 2.4-4 mm. Antenna 12-segmented; scape not attaining the posterior border of the head; funiculus noticeably enlarged toward the apex, the last 4 segments larger than the others but not forming a very clearly defined club. Mandibles rather large, subtriangular. Eyes usually vestigal or very small, with only a few ommatidia (some of the southern species, at least, have eyes larger than as described). Clypeus with a pair of longitudinal carinae. Promesonotal suture indistinct or absent.

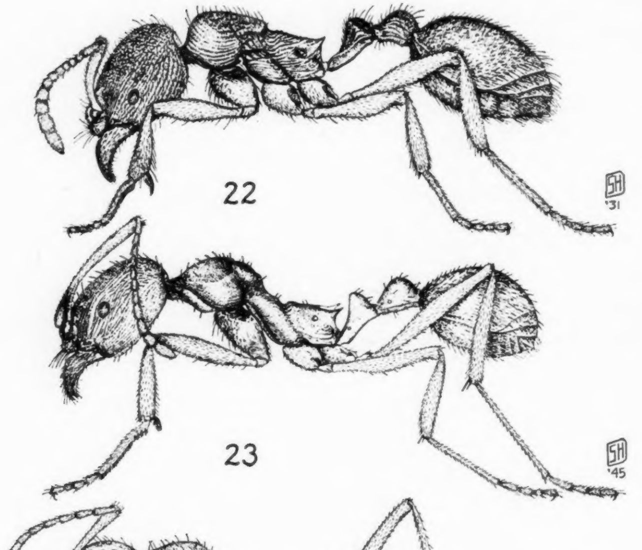


PLATE 6

Fig. 22. *Stenamma foveolocephalum* M. R. Smith, worker.
Fig. 23. *Aphaenogaster* (*Attomyrma*) *treatae* Forel, worker.
Fig. 24. *Novomessor cockerelli* (André), worker.
Fig. 25. *Veromessor pergandei* (Mayr), worker.

Promesonotum rather strongly convex and prominent. Meseopinotal region with a distinct to a very pronounced constriction. Epinotum usually with a pair of short spines, these sometimes almost tuberculate. Petiole very distinctly pedunculate. Postpetiole larger than petiole but not very strikingly so. Postpetiole separated from gaster by a rather pronounced constriction. Gaster oval, not truncate basally, the first segment occupying most of the gaster. Body, exclusive of gaster, largely covered with a rugulose to rugulose reticulate sculpture, which often gives a subopaque appearance. Color usually ranging from light brown through reddish brown to blackish. Nine forms, †*brevicorne* (Mayr), †*brevicorne diecki* Emery, †*brevicorne diecki impressum* Emery, †*brevicorne heathi* Wheeler, †*brevicorne impar* Forel, *brevicorne schmitti* Wheeler, †*brevicorne sequoiarum* Wheeler, †*foveolocephalum* M. R. Smith, *neoarcticum* Mayr. Distributed over the entire United States with the possible exception of the extreme southern parts. Colonies found east of the Mississippi River generally belong to *brevicorne* (Mayr) or are variants of it. Although not rare, these ants are not common in many collections. The various forms produce small colonies usually in the soil beneath logs, stones or debris. The workers are thought to be largely carnivorous.

APHAENOGASTER, subgenus ATTOMYRMA Emery

Pl. 6, Fig. 23

Aphaenogaster, subg. *Attomyrma* Emery, 1915, Accad. delle Sci. dell' Ist di Bologna Rend. (N. S.) **19**:70.
Subgenotype, *Formica subterranea* Latreille (by original designation).
Mayr, 1862, Zool.-Bot. Gesell. Wien, Verh. **12** (Abt. 2): 743.
*Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:444.
Forel, 1886, Soc. Ent. de Belg. Bul. (C. R.) **30**:40.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:301.
Pergande, 1895, Calif. Acad. Sci. Proc. (2) **5**:891.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:411.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:517.
Wheeler, 1932, N. Y. Ent. Soc. Jour. **40**:4.
Creighton, 1934, Psyche **41**:189-193.
*Wheeler and Wheeler, 1934, Psyche **41**:6, illus.
Smith, 1941, Great Basin Nat. **2**:118.
*Buren, 1944, Iowa State Col. Sci. **18**:284.
Smith, 1945, Ent. Soc. Amer. Ann. **27**:386, illus.

Monomorphic. Medium-sized (3.25-7 mm.), slender ants. Head usually distinctly longer than broad; in some forms very noticeably narrowed posteriorly (when the head is much narrowed posteriorly the antennae are usually long and slender). Eye generally prominent, usually not placed far from the middle of the side of the head. Frontal carinae short, not distant from each other. Anterior border of clypeus usually with a distinct median emargination. Antenna 12-segmented, the last 4 segments enlarged but not forming a very definite club, the last 3 segments shorter than the rest of the funiculus. Base of the scape with a prominent lobe in some forms (*treatae* Forel and its variants). Thorax usually with a distinct promesonotal suture. Anterior portion of mesonotum sometimes protuberant. Posterior third or more of mesonotum often very noticeably depressed. Meseopinotal suture distinct. Epinotum usually with a pair of spines of variable length (in only a few

forms are the spines vestigial or almost absent). Petiole generally pedunculate anteriorly, sometimes very much so. Gaster oval, not truncate basally, rather shining except for the sculpturing at base in a few forms. The subgenus includes some of our most common ants. Many of the forms prefer to nest in wooded areas. There are 37 forms, †*boulderensis* M. R. Smith, †*floridana* M. R. Smith, †*fulva* Roger, †*fulva aquia* (Buckley), †*fulva aquia picea* Emery, †*fulva aquia pusilla* Emery, †*fulva aquia rudis* Emery, *huachucana* Creighton, †*lamellidens* Mayr, †*lamellidens* var. *nigripes* M. R. Smith, †*mariae* Forel, †*mutica* Pergande, *patruelis bakeri* Wheeler, *patruelis willowsi* Wheeler, †*subterranea borealis* Wheeler, †*subterranea occidentalis* Emery, †*subterranea valida* Wheeler, †*subterranea valida manni* Wheeler, †*tennesseensis* (Mayr), *tennesseensis* var. *ecalcarata* Emery, †*texana* Emery, †*texana* var *carolinensis* Wheeler, †*texana flemingi* M. R. Smith, †*texana* var. *furvescens* Wheeler, †*texana macrospina* M. R. Smith, *texana* var. *miamiana* Wheeler, *texana nana* Wheeler, *texana punctithorax* Cole, *texana* var. *silvestrii* Menozzi, †*treatae* Forel, †*treatae* var. *ashmeadi* Emery, †*treatae harnedi* Wheeler, † *treatae pluteicornis* G. C. and E. W. Wheeler, *treatae pluteicornis alabamensis* G. C. and E. W. Wheeler, †*treatae pluteicornis oklahomensis* G. C. and E. W. Wheeler, *treatae wheeleri* Mann, †*uinta* Wheeler. One or more of these occur in every state; most of them, however, are found in the Southern and Eastern States. The ants form small to moderately large colonies in both soil and wood. So far as the author is aware workers are not known to attend honeydew-excreting insects; the workers are largely, if not almost entirely, carnivorous.

NOVOMESSOR Emery

Pl. 6, Fig. 24

Novomessor Emery, 1915, Accad. della Sci. dell' Ist. di Bologna Rend. (N. S.) **19**:73.
Genotype, *Aphaenogaster* (*Ischnomyrmex*) *cockerelli* André (by original designation).
*Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:443, 446.
André, 1893, Rev. Ent., p. 150.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., pp. 280-282, illus.
*Wheeler and Creighton, 1934, Amer. Acad. Arts and Sci. Proc. **69**:343-353, illus.

Large (6-8.5 mm.), slender ants with unusually long legs and antennae. Antenna 12-segmented; scape with an abrupt but weak enlargement toward the apex, funiculus without a well-defined club. Eye strongly convex, prominent. Promesonotal suture rather obsolescent. Mesoepinotal region without a well-defined suture separating the mesonotum and epinotum, as in *Aphaenogaster*. Epinotal spines rather closely placed basally, long and acute, as long as, or longer than, the space between their apices. Petiole either without a spine beneath or else with a very vestigial one. Hairs coarse, grayish, suberect to erect, moderately abundant to rather abundant on body; often curved beneath the head. Gaster very smooth and shining. Head largely longitudinally rugulose with punctate interspaces. Two forms, †*albisetosus* (Mayr) and †*cockerelli* (André), which are known from the arid regions of Texas, New Mexico and Arizona. *N. cockerelli* seems to be the more common. Both forms construct large crater nests in the soil, with an unusually conspicuous central opening leading into them. The colonies of *cockerelli*, at least, are

rather populous. Wheeler 1926, p. 282, says that the ants of this genus are not well-developed harvesters like those of *Veromessor*.

VEROMESSOR Forel

Pl. 6, Fig. 25

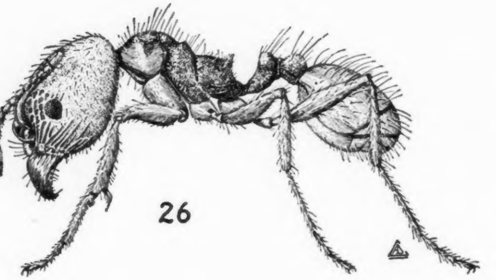
Novomessor, subg. *Veromessor* Forel, 1917, Soc. Vaud. des Sci. Nat. Bul. **51**:235.
Genotype, *Aphaenogaster andrei* Mayr (by designation of Emery, 1921).
*Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:443, 448-449.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:306, 307.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:410.
Andrews, 1916, Psyche **23**:81.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 280, illus.
*Wheeler and Creighton, 1934, Amer. Acad. Arts and Sci. Proc. **69**:354-368, 371-382, 385, illus.

Length 4-7 mm. (The smallest worker of the highly polymorphic *pergandei* measures 2.5 mm.). Head subrectangular to subquadrate. Middle of anterior border of clypeus often with an impression, groove, or even a tooth. Antenna 12-segmented; scape usually not reaching or surpassing the posterior border of the head, the base of the scape in some forms trumpet-shaped or spatulate; funiculus gradually enlarging toward the apex with the last 4 or 5 segments somewhat larger than the others but not forming a well-defined club. Eye usually well-developed. Promesonotal suture often obsolete. Mesoepinotal region with an impression varying from moderate to broad and deep. Epinotal spines highly variable in length, ranging from shorter than the interbasal space to considerably longer than this distance. Legs not unusually long as in *Novomessor*, the femore sometimes incrassated. Hairs usually rather abundant on the body; ventral surface of head in *pergandei* with well-developed psammophore. Sculpturing highly variable, most often largely rugulose or rugulose reticulate on head and thorax (very feeble sculpturing on *pergandei* thus giving the regions mentioned a shining effect). Seven forms, †*andrei* (Mayr), *andrei castaneus* Wheeler and Creighton, *andrei flavus* Wheeler and Creighton, *chamberlini* (Wheeler), †*lobognathus* (Andrews), †*pergandei* (Mayr), and †*stoddardi* (Emery). The most common are *pergandei* and *andrei*. One or more forms occur in Colorado, Nevada, Arizona and California. All 7 forms, except perhaps *lobognathus*, occur in California. These harvesting ants nest in the soil. Their food consists largely of seeds supplemented by the flesh of arthropods. Such species as *pergandei* are markedly xerophytic.

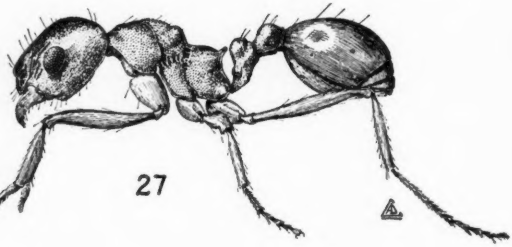
PHEIDOLE Westwood

Pl. 7, Fig. 26

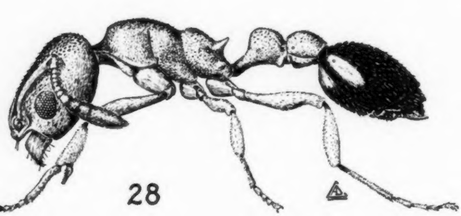
Pheidole Westwood, 1841, Ann. and Mag. Nat. Hist. **6**:87.
Subgenotype, (*Atta providens* Sykes) = *Pheidole indica* Mayr (by designation of Bingham, 1903).
Fabricius, 1793, Ent. System. **2**:361.
Roger, 1863, Berlin. Ent. Ztschr. **7**:180, 199.
*Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:987, 989.
Mayr, 1886, Zool-Bot. Gesell. Wien, Verh. **36**:455.
Forel, 1886, Soc. Ent. de Belg. Bul. (C. R.) **30**:45-46.
Mayr, 1887, Zool.-Bot. Gesell. Wien, Verh. **37**:596-598.



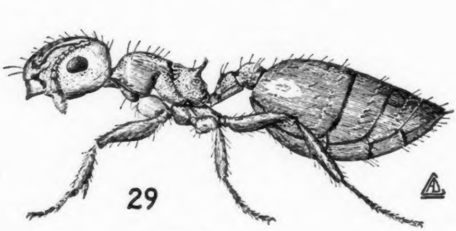
26



27



28



29

PLATE 7

Fig. 26. *Pheidole hyatti* Emery, soldier.
Fig. 27. *Epipheidole inquilina* Wheeler, worker.
Fig. 28. *Cardiocondyla emeryi* Forel, worker.
Fig. 29. *Crematogaster (Orthocrema) minutissima missouriensis* Emery, worker.

*Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:288.
Pergande, 1895, Calif. Acad. Sci. Proc. (2) **5**:885.
Emery, 1896, Soc. Ent. Ital. Bol. **28**:76.
Emery, 1901, Soc. Ent. de France Bul., p. 120.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:348-352.
Wheeler, 1901, Amer. Nat. **35**:534, illus.
Wheeler, 1903, Psyche **10**:95, illus.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:10.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:379.
Wheeler, 1906, Amer. Mus. Nat. Hist. Bul. **22**:336.
Wheeler, 1907, Amer. Mus. Nat. Hist. Bul. **23**:18.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:431, illus.
Forel, 1908, Soc. Vaud. des Sci. Nat. Bul. **44**:55.
Santschi, 1909, Soc. Ent. Ital. Bol. **41**:3, illus.
Wheeler, 1914, N. Y. Ent. Soc. Jour. **22**:49-51.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:397.
Wheeler, 1916, New Engl. Zool. Club Proc. **6**:29, illus.
Wheeler, 1916, Psyche **23**:40.
Forel, 1922, Rev. Suisse Zool. **30**:92.
Smith, 1924, Ent. News **35**:251.
Smith, 1927, Ent. News **37**:310.
Cole, 1933, Ent. Soc. Amer. Ann. **26**:616.
Smith, 1934, Ent. Soc. Amer. Ann. **27**:385.
Cole, 1936, Canad. Ent. **68**:35.
Smith, 1943, Ent. Soc. Wash. Proc. **45**:5.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:285.

Length 1.3-8 mm. Normally dimorphic; a few forms however, such as *rhea* and *kingi instabilis,* polymorphic. Head unusually large, often enormous in proportion to the remainder of the body; subrectangular, subquadrate, or subcordate with emarginate posterior border and prominent occipital lobes. Occipital lobes usually separated by a prominent frontal groove which often extends anteriorly almost to the clypeus. Anterior border of the clypeus usually with a median emargination. Mandibles well-developed, sometimes rather large, usually with 2 apical teeth, a basal tooth and some smaller teeth or no teeth between these. Frontal carinae variable in shape but seldom forming a scrobe for the reception of the scape. Antenna 12-segmented, with a distinct, 3-segmented club. Scape variable in regard to length and shape, usually slender or else much flattened at the base. Promesonotum usually larger and more convex than the remainder of the thorax. Mesonotum in some forms marked by a conspicuous transverse furrow. Mesoepinotal region with a very distinct constriction. Epinotum with a pair of spines which are seldom vestigal. Petiole pedunculate anteriorly. Postpetiole often angulate or conulate on the side. Sculpturing of head, thorax, petiole and postpetiole very diverse, often forming a pattern which is more or less distinctive in each form.

Worker smaller and more slender than the soldier. Head not so remarkably large or strikingly out of proportion to the remainder of the body. Occipital lobes either lacking or weakly developed. Promesonotal region not so stout or prominent as in the soldier. Worker of some forms with the general habitus of a *Monomorium, Aphaenogaster* or *Leptothorax (Dichothorax).* One of our largest genera with 85 forms. One or more forms are believed to occur in every state; most of them, however, are found in the Southwest

and South, especially in the Southwest. The ants usually form small to moderately large colonies in the soil either beneath objects or free of cover. They may also nest in well-rotted wood such as logs and stumps. The workers feed mainly on seeds and the flesh of small arthropods. Some forms are strongly predaceous. The workers are not so fond of honeydew as are the workers of such genera as *Myrmica, Solenopsis* and *Crematogaster.* Our forms are *anastasii* Emery, †*anastasii* var. *cellarum* Forel, *barbata* Wheeler, †*bicarinata* Mayr, †*californica* Mayr, †*californica* var. *hagermani* Cole, *californica* var. *incenata* Wheeler, *californica micula* Wheeler, †*californica oregonica* Emery, *californica pyramidensis* Wheeler, *californica* var. *satura* Wheeler, *californica* var. *shoshoni* Cole, †*casta* Wheeler, †*ceres* Wheeler, †*cockerelli* Wheeler, †*constipata* Wheeler, †*crassicornis* Emery, †*crassicornis* var. *diversipilosa* Wheeler, †*crassicornis porcula* Wheeler, †*crassicornis porcula tetra* Wheeler, *crassicornis vallicola* Wheeler, *davisi* Wheeler, †*dentata* Mayr, †*dentata* var. *commutata* Mayr, *dentata* var. *faisonica* Forel, †*dentigula* M. R. Smith, †*desertorum* Wheeler, †*desertorum* var. *comanche* Wheeler, †*desertorum* var. *maricopa* Wheeler, †*floridana* Emery, †*grallipes* Wheeler, †*hayesi* M. R. Smith, *humeralis* Wheeler, †*hyatti* Emery, †*hyatti* var. *ecitonodora* Wheeler, *hyatti solitanea* Wheeler, †*kingi instabilis* Emery, *kingi torpescens* Wheeler, †*lamia* Wheeler, †*lauta* Wheeler, *macclendoni* Wheeler, *marcidula* Wheeler, †*megacephala* (Fabricius), †*metallescens* Emery, †*metallescens splendidula* Wheeler, †*militicida* Wheeler, †*morrisi* Forel, †*morrisi* var. *impexa* Wheeler, †*morrisi* var. *vanceae* Forel, *nuculiceps* Wheeler, †*pilifera* (Roger), †*pilifera artemisia* Cole, †*pilifera coloradensis* Emery, *pilifera* var. *neomexicana* Wheeler, *pilifera septentrionalis* Wheeler, *pilifera* var. *simulans* Wheeler, *pinealis* Wheeler, *proserpina* Wheeler, †*rhea* Wheeler, *ridicula* Wheeler, †*sciophila* Wheeler, †*sciophila* var. *semilaevicephala* M. R. Smith, †*sitarches* Wheeler, †*sitarches rufescens* Wheeler, *sitarches rufescens campestris* Wheeler, *sitarches* var. *transvarians* Wheeler, †*soritis* Wheeler, *spadonia* Wheeler, *tepicana cavigenis* Wheeler, †*texana* Wheeler, *titanis* Wheeler, †*tysoni* Forel, †*vasliti subdentata arizonica* Santschi, †*vinelandica* Forel, †*vinelandica buccalis* Wheeler, *vinelandica cerebrosior* Wheeler, †*vinelandica laeviuscula* Emery, †*vinelandica longula* Emery, *vinelandica longula castanea* Wheeler, *vinelandica* var. *nebrascensis* Forel, *virago* Wheeler, †*xerophila* Wheeler, *xerophila pacifica* Wheeler, †*xerophila tucsonica* Wheeler, *xerophila tucsonica gilvescens* Wheeler.

EPIPHEIDOLE Wheeler

Pl. 7, Fig. 27

Epipheidole Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:14.
Genotype, *Epipheidole inquilina* Wheeler (monobasic).
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:15, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 497, illus.
Smith, 1940, Ent. Soc. Wash. Proc. **42**:104, illus.

Length 2 mm. Head subquadrate, with deeply emarginate posterior border; occipital lobes subangular. Eye prominent, strongly convex, placed somewhat anterior to the middle of the side of the head. Frontal carinae subparallel. Frontal groove weak but distinct, extending from the frontal area towards the posterior border of the head. Antenna 12-segmented; scape

slender, slightly enlarged apically; funiculus with a 3-segmented club, the last segment of which exceeds the combined length of the 2 preceding segments. Mesoepinotal region with a broad and deep constriction. Epinotum with a pair of large, bluntly tipped, fingerlike spines. Petiolar node, from behind, with horizontal, entire, blunt, superior border. Postpetiole, from above, approximately as broad as long, subangular near the middle of each side. Spurs of middle and hind tibiae apparently lacking. Gaster oval, subtruncate at base, without well-defined, angular humeri. Cheeks, region between eyes, frontal carinae, and front, with a few weak, longitudinal rugulae. Epinotum somewhat rugulose, especially in the region of the mesoepinotal constriction. Posterior dorsal surface of head with a few scattered foveolae. Hairs suberect to erect, sparse. One form, †*inquilina* Wheeler, which is parasitic in colonies of *Pheidole pilifera* (Roger) and its subspecies *coloradensis* Emery. Extremely rare. Previous to 1940 (Smith, above citation) the genus *Epipheidole* was thought to be without workers. The discovery of a single worker however, proves that the worker caste has not been entirely lost. It seems quite evident that the ants of this genus must have arisen from a *Pheidole* ancestor like that of the host or of a closely related species.

SYMPHEIDOLE Wheeler

Sympheidole Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:7.
Genotype, *Sympheidole elecebra* Wheeler (monobasic).
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:8, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 497, illus.

The female of *S. elecebra* can be distinguished by the following characters: Habitus of a *Pheidole*. Length 2.75-3 mm. Head as broad as long with rounded anterior and posterior corners and convex sides, thus giving it a rounded appearance. Antenna 12-segmented, with 3-segmented club, scape extending to the posterior corner of the head. Prothorax with rounded humeri. Epinotal spines small and acute. Postpetiole very broad and short, with unusually prominent lateral angles which are directed somewhat posteriorly. Body and appendages with abundant, long, reclinate hairs which appear obtuse at the ends under low magnification, and frayed into short, acute processes when examined under high magnification.

The ants of this genus which are closely allied to *Pheidole* are parasitic in colonies of *Pheidole ceres* Wheeler. The single form, *elecebra* Wheeler, is known only from type material collected in Colorado (near Boulder, and Ute Pass near Manitou). Only males and females have been found; hence it is assumed that the worker caste is lacking. Since parasitized colonies contain only workers and soldiers of *ceres* it is believed that the parasite does not permit males and females of the host to exist.

CARDIOCONDYLA Emery

Pl. 7, Fig. 28

Cardiocondyla Emery, 1869, Accad. degli Aspiranti, Naples Ann. (2) **2**:21.
Genotype, *Cardiocondyla elegans* Emery (monobasic).
Forel, 1881, Mitt. Muenchen. Ent. Ver. **5**:5, illus.
André, 1881, Soc. Ent. de France Ann. (6) **1**:69, illus.

Forel, 1899, Fauna Hawaiiensis, Formicid. **1**(1):120.
*Emery, 1909, Deut. Ent. Ztschr., p. 19, illus.
Arnold, 1916, So. Afr. Mus. Ann. **14**:200, illus.
Smith, 1930, Fla. Ent. **14**:4.
Wheeler, 1929-1931, Bol. Lab. Zool. Gen. e. Agr. R. Scuola Super. Agr. Portici **24**:43.
Wheeler, 1932, N. Y. Ent. Soc. Jour. **40**:7.
Borgmeier, 1937, Rev. de Ent. **7**:129, illus.
*Smith, 1944, Ent. Soc. Wash. Proc. **46**:30, illus.

Monomorphic. Slender ants. Length 1.6-2.5 mm. Habitus of *Leptothorax*. Head subrectangular, longer than broad. Antenna 12-segmented; funiculus with a 3-segmented club, funicular segments 3 through 5 as broad as, or broader than, long. Eye prominent, placed less than its greatest diameter from the base of the mandible. Frontal carinae short, scarcely divergent posteriorly. Clypeus projecting above mandibles (best seen in profile). Prothorax usually with pronounced humeri. Promesonotal suture obsolescent or absent. Mesoepinotal constriction sometimes absent but more often weakly to strongly defined. Epinotum with a pair of short or moderately long, rather blunt spines (spines occasionally almost tuberculate). Petiole very distinctly pedunculate, especially anteriorly. Postpetiole very noticeably broader than the petiole, much broader than long, with subparallel anterior and posterior borders and rounded sides. First segment comprising most of gaster. Head and thorax usually subopaque, reticulate punctate. Body clothed with very closely appressed pubescence. Erect hairs almost, if not entirely, absent except on mandibles, clypeus, and apex of gaster. Four forms, †*emeryi* Forel, †*nuda* var. *minutior* Forel, †*venustula* Wheeler, and †*wroughtoni* var. *bimaculata* Wheeler. These are known to occur only in Florida and are very probably introduced. Specimens are not found in many American collections. Nests are constructed in the soil and also within the cavities of plants such as sedges. The colonies are small. The food of the worker is thought to be honeydew and the flesh of small arthropods. There are both normal and ergatoid males in this genus. The ergatoid males are of two types, (a) and (b). The (a) type has an 11-segmented antenna, a long, curved, tapering mandible without masticatory border, an emarginate clypeus and an apterous thorax; the (b) type has a 12-segmented antenna, an apterous thorax, a mandible with 4 or 5 teeth, the eye not as large as in normal male, and more pronounced prothoracic humeri than the worker. *C. emeryi* and *bimaculata* have the (a) type ergatoid male, and *minutior* and *venustula* the (b) type. So far as the author is aware normal males have not been observed in any of the species except *emeryi* and with this species they seem to occur more frequently than ergatoid males.

CREMATOGASTER, subgenus ORTHOCREMA Santschi
Pl. 7, Fig. 29

Crematogaster, subg. *Orthocrema* Santschi, 1918, Soc. Ent. de France Bul., p. 182.
Subgenotype, *Myrmica sordidula* Nylander (by original designation).
*Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:991, 995.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:288.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:482, illus.
*Creighton, 1939, Psyche **46**:137.

Length 2-3.5 mm. Antennae 11-segmented. Differing from *Crematogaster (Acrocoelia)* mainly as follows: Funiculus with a 2-segmented club. Basal surface of epinotum vestigial or lacking. Epinotal spines short, much shorter than their interbasal space. Petiolar node as long as broad or longer than broad, subrectangular or subelliptical. Postpetiole broader than long, convex above, without an impression or longitudinal furrow. General color yellowish in all forms except *arizonensis*. Four forms, †*arizonensis* Wheeler, †*minutissima minutissima* Mayr, †*minutissima missouriensis* Emery, *minutissima thoracica* Creighton. The ants of this subgenus are largely southern in distribution. Colonies nest in the soil or in wood. The biology is not well-known. The workers no doubt attend honeydew-excreting insects and feed on flesh like those of the subgenus *Acrocoelia*. *C. minutissima missouriensis* is one of the most common forms.

CREMATOGASTER, subgenus ACROCOELIA Mayr

Pl. 8, Fig. 30

Crematogaster, subg. *Acrocoelia* Mayr, 1852 [1853], Zool.Bot. Gesell. Wien, Verh. **2**:146.

Subgenotype, (*Acrocoelia ruficeps* Mayr) = *Formica scutellaris* Olivier (by designation of Bingham, 1903).

Say, 1836, Boston Jour. Nat. Hist. **1**:290.
Fitch, 1854, N. Y. State Agr. Soc. Trans. **14**:835.
Mayr, 1866, Zool.-Bot. Gesell. Wien, Verh. **16**:901, illus.
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:989-993.
Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:462.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:280.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:478.
Wheeler, 1919, Psyche **26**:107, illus.
Wheeler, 1930, Psyche **37**:55.
Wheeler, 1932, N. Y. Ent. Soc. Jour. **40**:8.
Wheeler, 1933, Psyche **40**:83.

Monomorphic. Length 2.5-4.5 mm. Head usually subquadrate or subrectangular. Antenna 11-segmented: funiculus with a 3-segmented club. Eye prominent. Frontal carinae short, subparallel, well-separated. Clypeus well-developed. Mandible with short masticatory border. Thorax short, stout. Mesoepinotal region with a pronounced constriction. Promesonotum often with a longitudinal carina. Epinotum bearing a pair of spines of variable length and size. Petiole trapezoidal, broadest anteriorly. Postpetiole with an impression or longitudinal furrow, which forms 2 more or less distinct lobes. Postpetiole attached to dorsal surface of base of gaster. Gaster subcordate, more convex ventrally than dorsally, and with acute apex. Sculpturing of head and thorax highly variable, especially that of the latter. Nineteen forms, †*ashmeadi* Mayr, †*ashmeadi* var. *matura* Wheeler, †*atkinsoni* Wheeler, *atkinsoni* var. *helveola* Wheeler, †*coarctata* Mayr, †*coarctata* var. *mormonum* Emery, *creightoni* Wheeler, *kennedyi* Wheeler, †*laeviuscula* Mayr, †*laeviuscula* var. *californica* Emery, †*laeviuscula* var. *clara* Mayr, †*lineolata* (Say), †*lineolata* var. *cerasi* (Fitch), †*lineolata* var. *lutescens* Emery, †*lineolata* var. *subopaca* Emery, *opaca* var. *depilis* Wheeler, †*opaca* var. *punctulata* Emery, †*pilosa* Emery, †*vermiculata* Emery. One or more forms occur in every state. Two of these, *creightoni* and *kennedyi*, are parasitic and apparently

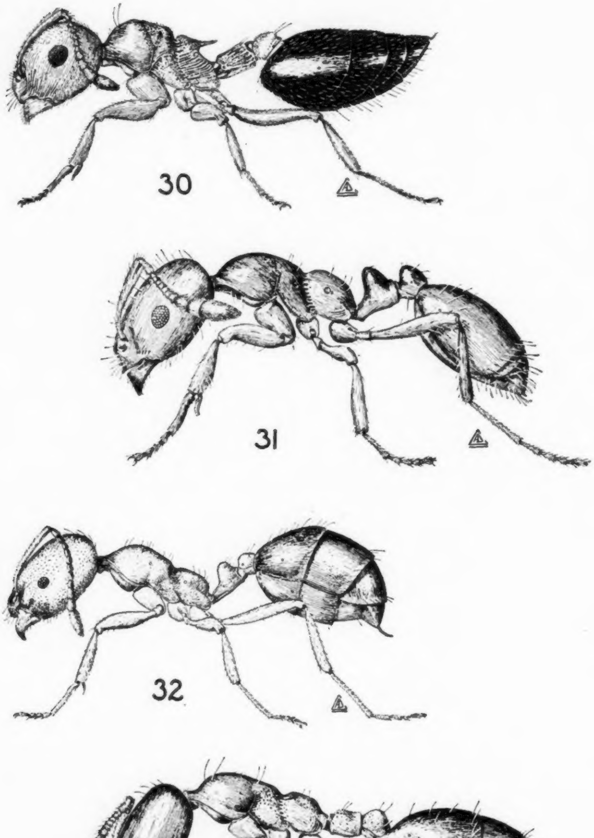


PLATE 8

Fig. 30. *Crematogaster* (*Acrocoelia*) *laeviuscula* var. *clara* Mayr, worker.
Fig. 31. *Monomorium* (*Monomorium*) *minimum* (Buckley), worker.
Fig. 32. *Monomorium* (*Parholcomyrmex*) *destructor* (Jerdon), worker.
Fig. 33. *Xenomyrmex stolli floridanus* Emery, worker.

workerless. The former is found in colonies of *pilosa,* and the latter in colonies of *lineolata* var. near *cerasi.* Members of this subgenus are some of our most common ants. Colonies nest in the soil, in wood, crevices of plants, insect galls, and carton nests of their own making *(atkinsoni* and its var. *helveola).* The workers are noted for their attendance on honeydew-excreting insects. Some forms such as *lineolata, laeviuscula,* and *ashmeadi* nest in houses and infest human foods. The worker's habit of elevating the gaster in such a way that it resembles the action of a scorpion has earned for the ant, the name, acrobatic ant. Although the ants are easy to recognize generically and subgenerically, their identification to species or subspecies is often very difficult because of the numerous intergrading forms.

MONOMORIUM, subgenus MONOMORIUM Mayr

Pl. 8, Fig. 31

Monomorium Mayr, 1855, Zool.-Bot. Gesell. Wien, Verh. **5**:452.
Subgenotype, *Monomorium minutum* Mayr (monobasic).
Buckley, 1867, Ent. Soc. Phila. Proc. **6**:338.
*Bingham, 1903, Fauna Brit. India Hymen. **2**:201, 202, 211.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:269.
Emery, 1908, Deut. Ent. Ztschr., pp. 664, 682, 684.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:584.
*Smith, 1919, Ohio Jour. Sci. **19**:290.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 95, illus.
*Donisthorpe, 1927, British Ants, Geo. Routledge and Sons, London, 2d ed., p. 103.
*Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:831, 833-834.
*Metcalf and Flint, 1939, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., p. 770.
Brown, 1943, Ent. News **54**:243.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:289.

Monomorphic. Length 1.5-2.5 mm. Head noticeably longer than broad. Antenna 12-segmented, with a well-defined 3-segmented club. Clypeus with a pair of longitudinal carinae which are extended on the anterior border as more or less distinct teeth (the carinae are sometimes difficult to see). Mandible with short masticatory border bearing 3 or 4 distinct teeth. Frontal carinae short. Eye well-developed. Prothorax with rounded humeri. Promesonotal suture obsolescent or absent. Meseopinotal region with pronounced constriction. Epinotum unarmed. Gaster with distinct basal angles. Body largely smooth and shining except that of *pharaonis* which is densely punctate and subopaque on the head, thorax, petiole and postpetiole. Hairs simple, scattered. This subgenus contains 5 forms, †*minimum* (Buckley), of the entire United States, and its variety *ergatogyna* Wheeler of California, †*floricola* (Jerdon) of Florida, the introduced †*pharaonis* (Linnaeus) of many of our towns and cities, especially those of commercial importance, and *viridum* Brown of New Jersey. Colonies may nest in the soil, in wood, crevices of plants, or *(pharaonis)* even in houses and buildings. Such forms as *minimum* and *pharaonis* are important house-infesting ants. *M. ergatogyna* and *M. floricola* have ergatoid females, that is, workerlike females with ocelli, large eyes, and a thorax more or less like that of the female but without vestiges of wings. The supposedly parasitic ant, *Epoecus pergandei* Emery, which has only males and females, was found in a nest of *Monomorium minimum* at Washington, District of Columbia.

MONOMORIUM, subgenus PARHOLCOMYRMEX Emery

Pl. 8, Fig. 32

Monomorium, subg. *Parholcomyrmex* Emery, 1915, Soc. Ent de France Bul., p. 190.
Genotype, *Myrmica gracillima* F. Smith (by original designation).
*Bingham, 1903, Fauna British India Hymen. **2**:201, 209.
Wheeler, 1906, Ent. News **17**:23.
*Emery, 1908, Deut. Ent. Ztschr., pp. 665, 671.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., pp. 10, 153, 221.
*Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:831, 833.

Differing from subgenus *Monomorium* mainly as follows: Worker extremely variable in size (length 1.8-3 mm.) with a tendency to dimorphism in the single form, †*destructor* (Jerdon). Head of largest worker not so long in proportion to its breadth as in the smaller workers. First 2 segments of antennal club subequal. Clypeal carinae and teeth obsolescent or absent. Posterior border of head and posterior surface of epinotum with weak to moderately strong, transverse rugulae. *M. destructor* has been introduced into several southern towns and cities (at least in the states of Florida and Tennessee). This important house-infesting ant normally nests in the soil but may also nest in buildings or even ships. The form is readily distinguished by its shining, yellowish-red worker which has the meso- and metapleura and the epinotum sculptured and subopaque, and the apex of the gaster infuscated.

XENOMYRMEX Forel

Pl. 8, Fig. 33

Xenomyrmex Forel, 1884, Soc. Vaud. des Sci. Nat. Bul. **20**:369.
Genotype, *Xenomyrmex stolli* Forel (monobasic).
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:275.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 432.
*Wheeler, 1931, Rev. de Ent. **1**:129, illus.

Length 1.7 mm. Monomorphic. Head rather large, subrectangular. Eye not large but prominent, located in the anterior half of the side of the head. Middle of the anterior border of the clypeus in the form of a bidentate lobe. Antenna 11-segmented; scape lacking a great deal of attaining the posterior border of the head; funiculus with a 3-segmented club, the last segment of which is longer than the 2 preceding segments combined. Prothorax without humeral angles. Promesonotal suture absent. Mesoepinotal region very strongly impressed. Epinotum unarmed. Petiole nonpedunculate. Legs with incrassated femora and tibiae. Gaster perceptibly narrowed at base. Integument smooth or weakly sculptured. Two forms, †*stolli floridanus* Emery and *stolli rufescens* Wheeler, both of Florida. Arboreal. Nests constructed in plant cavities. Uncommon. Habitus somewhat like that of a *Monomorium*.

SOLENOPSIS, subgenus SOLENOPSIS Westwood

Pl. 9, Fig. 34

Solenopsis Westwood, 1841, Ann. and Mag. Nat. Hist. **6**:86.
Genotype, (*Solenopsis mandibularis* Westwood) = *Atta geminata* Fabricius (monobasic).

Fabricius, 1804, Syst. Piez., p. 423.
Jerdon, 1851, Madras Jour. Lit. Sci. **17**:106.
McCook, 1879, *in* Comstock's Report on Cotton Insects, p. 188, illus.
Wheeler, 1906, Amer. Mus. Nat. Hist. Bul. **22**:336.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:425.
Forel, 1909, Deut. Ent. Ztschr., p. 267.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:394, 396.
*Creighton, 1930, Amer. Acad. Arts and Sci. Proc. **66**:59, 66, 87, 98, 102-104, illus.
Smith, 1936, Jour. Econ. Ent. **29**:120.
Metcalf and Flint, 1939, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., p. 771.
Eagleson, 1940, Jour. Econ. Ent. **33**:700.

Polymorphic. Length 1.6-6 mm. Antenna 10-segmented, with a conspicuous 2-segmented club. Clypeus bicarinate, its anterior border usually with from 2 or 3 to as many as 5 teeth; occasionally toothless, however. Frontal carina short. Mandible with a small number of teeth, usually 4 or less, sometimes without teeth (major workers of *geminata* and its subspecies *rufa*). Eye well-developed, never with less than 20 facets and usually with 30 or more. Mesoepinotal region with distinct to well-developed suture or impression. Epinotum unarmed. Most of body smooth and shining. Seven forms, †*geminata* (Fabricius), †*geminata rufa* (Jerdon), †*saevissima* var. *richteri* Forel, †*xyloni* McCook, *xyloni amblychila* Wheeler, *xyloni aurea* Wheeler, †*xyloni* var. *maniosa* Wheeler. East of the Mississippi River ants of this subgenus apparently do not extend very far north of the 35th degree of latitude, although in the West they apparently extend much farther North, reaching at least the Sacramento Valley in California. Colonies usually nest in the soil, most often freely exposed. From a pest standpoint the first four of the forms mentioned and *xyloni maniosa* are among the most important ants in the United States. Workers are known to steal seed from seed beds, infest houses, kill young quail and poultry as they are hatching from the egg, gnaw holes in various types of cloth and clothing, gnaw into vegetables, flowers, and fruits, attend honeydew-excreting insects, sting severely and injure telephone equipment. The ants are especially noted for their aggressiveness. The workers are also predaceous and carnivorous. *S. saevissima richteri* has apparently been introduced into Alabama and Mississippi from South America.

SOLENOPSIS, subgenus EUOPHTHALMA Creighton

Pl. 9, Fig. 35

Solenopsis, subg. *Euophthalma* Creighton, 1930, Amer. Acad. Arts and Sci. Proc. **66**:43.
Subgenotype, *Myrmica globularia* F. Smith (by original designation).
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:393.
Creighton, 1930, Amer. Acad. Arts and Sci. Proc. **66**:105, 110, 113, 118, illus.

Characters same as for the subgenus *Solenopsis* except as follows: Monomorphic to feebly polymorphic. Length 1.5-2.2 mm. Eye with 18-22 facets. Clypeus bicarinate, terminating on the anterior border in 2 prominent teeth; lateral teeth often poorly developed or absent. (Postpetiole remarkably large, subelliptical in *globularia littoralis*). Two forms, *huachucana* Wheeler and †*globularia littoralis* Creighton. The former was described from speci-

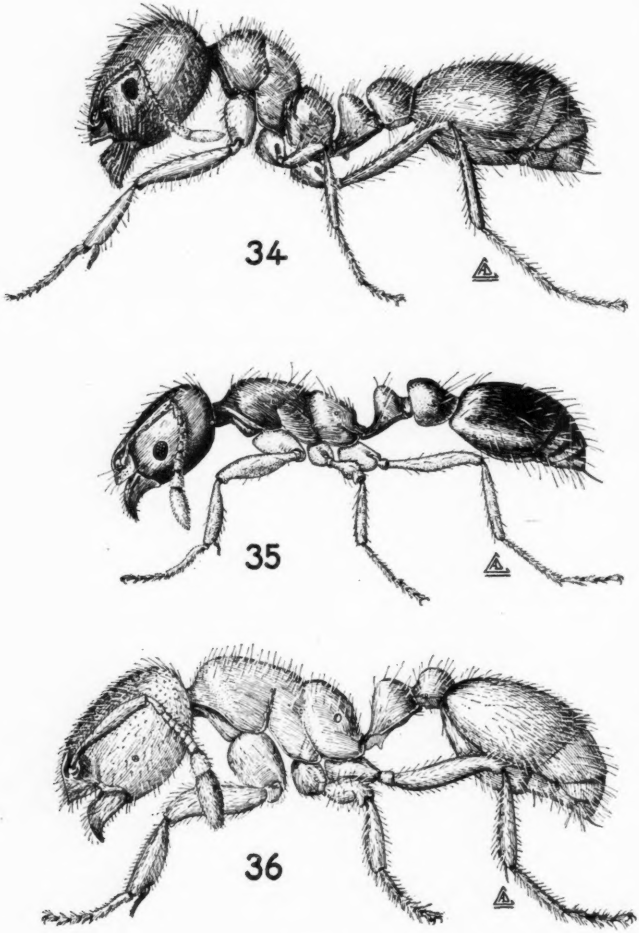


PLATE 9

Fig. 34. *Solenopsis* (*Solenopsis*) *xyloni* McCook, soldier.
Fig. 35. *Solenopsis* (*Euophthalma*) *globularia littoralis* Creighton, worker.
Fig. 36. *Solenopsis* (*Diplorhoptrum*) *pergandei* Forel, worker.

mens collected in the Huachucha Mountains of Arizona. *S. globularia littoralis* is apparently confined largely to the littoral areas from North Carolina to Mississippi, and perhaps even to Texas. The ants of this subspecies seem to prefer to nest in well-rotted logs. Very little is known about their biology.

SOLENOPSIS, subgenus DIPLORHOPTRUM Mayr

Pl. 9, Fig. 36

Diplorhoptrum Mayr, 1855, Zool.-Bot. Gesell. Wien, Verh. **5**:449.
Subgenotype, *Formica fugax* Latreille (monobasic).
Say, 1835, Boston Jour. Nat. Hist. **1**:293.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:277.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:343, 345, 346.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:269.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:426, illus.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:393.
Hayes, 1920, Kans. Agr. Expt. Sta. Tech. Bul. 5, 55 pp., illus.
Kennedy, 1938, Canad. Ent. **70**:232, illus.
Metcalf and Flint, 1939, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., p. 770.
Smith, 1942, Ent. Soc. Wash. Proc. **44**:209.

Monomorphic. Length 1.2-2.7 mm. Eye very small with 15 facets or less, often not more than 2 or 3. Second and third funicular segments usually as broad as long or broader than long. Antenna with 10 segments. Fifteen forms, †*krockowi* Wheeler, †*longiceps* M. R. Smith, †*molesta* (Say), *molesta* var. *castanea* Wheeler, †*molesta* var. *validiuscula* Emery, †*pergandei* Forel, †*picta* Emery, *picta* var. *moerens* Wheeler, †*pilosula* Wheeler, *rosella* Kennedy, *salina* Wheeler, *texana* Emery, *texana carolinensis* Forel, *texana catalinae* Wheeler, *texana truncorum* Forel. The largest subgenus of *Solenopsis* with one or more forms in every state. Most of these occur in the South and Southwest. Many of the ants of this subgenus nest in the soil but some nest in wood, plant cavities or even in insect galls. *S. molesta* is one of the most widely distributed members of the subgenus. This ant is an important economic form. It is known to infest houses, attack germinating grain in the ground and attend plant lice. For a full account of its biology and economic significance see Hayes, 1920.

EPOECUS Emery

Pl. 10, Fig. 37

Epoecus Emery, 1892, Soc. Ent. de France Ann. (Bul.) 61: cclxxvi.
Genotype, *Epoecus pergandei* Emery (monobasic).
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:273, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 498, illus.

The genus is represented by a single form, *pergandei* Emery, which was collected from a colony of *Monomorium minimum* (Buckley) in Washington, District of Columbia. The host colony contained only winged males and winged females. As only males and females of *Epoecus* were noted, the ants of this genus are supposed to be workerless and parasitic. The biology of *pergandei* is very poorly known since the ant has been collected on only this one occasion. The female of *E. pergandei* can be distinguished from

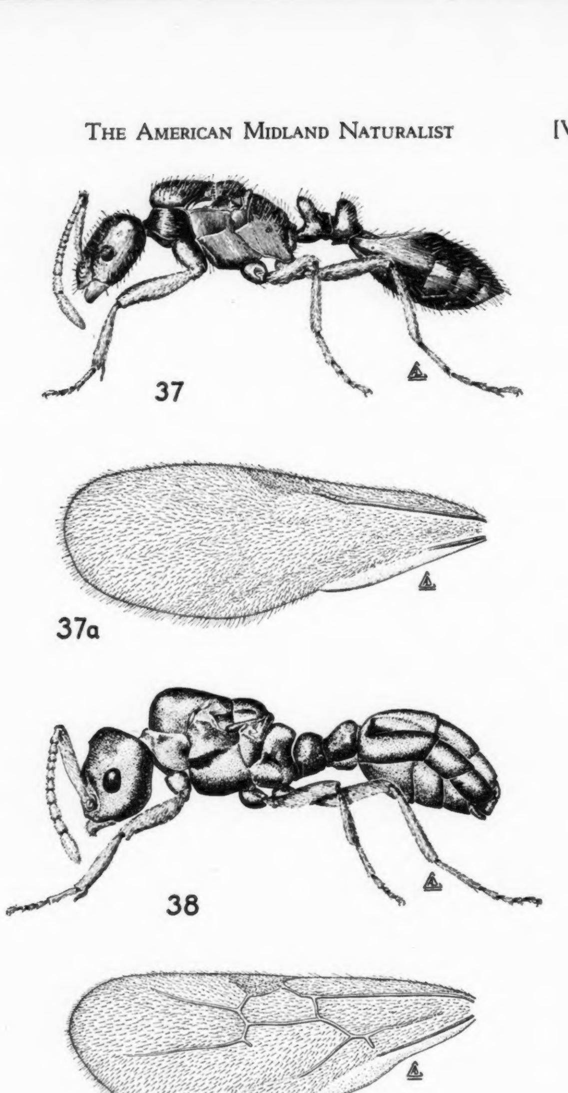


PLATE 10

Fig. 37. *Epoecus pergandei* Emery, female; fig. 37 a, anterior wing.
Fig. 38. *Anergates atratulus* (Schenck), female; fig. 38 a, anterior wing.

the females of forms in other genera by her size (2.2-2.5 mm.), the strong impression on at least the dorsal surface of the first gastric segment, the elongate head, bidentate clypeus, 11- to 12-segmented antenna, very long antennal scape, unarmed epinotum, and the scalelike petiolar node which is directed anterodorsally.

ANERGATES Forel

Pl. 10, Fig. 38

Anergates Forel, 1874, Schweiz. Naturf. Gesell. Denkschr. **26**:93.
Genotype, *Myrmica atratula* Schenck (monobasic).
Schenck, 1852, Jahrb. Ver. Naturk. Nassau **8**:91.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 498, illus.
Donisthorpe, 1927, British Ants, Geo. Routledge and Sons, London, 2d ed., p. 96, illus.
Creighton, 1934, Psyche **41**:193.
Bridwell, 1937, Ent. Soc. Wash. Proc. **39**:14.

These ants are parasites of the introduced pavement ant, *Tetramorium caespitum* (Linnaeus). The worker caste of *Anergates* has apparently been lost, only males and females being known. A parasitized colony of the host species contains only workers of *T. caespitum*. The single form, *atratulus* (Schenck) is extremely rare, specimens having been collected on only one occasion each in Delaware, Virginia and Connecticut. The virgin female of *Anergates* which is 2.5 mm. long can be readily distinguished from the female of forms in other genera by the prominent longitudinal furrow on the dorsal surface of the gaster. Other helpful characters are the stout form of the body, 11-segmented antenna, emarginate clypeus, and bituberculate epinotum. Since *Anergates* is now known to occur in the United States another genus of ants, *Strongylognathus*, with forms also parasitic on *T. caespitum*, may eventually be found. For an interesting account of the biology of *atratulus* see Wheeler 1926 and Donisthorpe 1927.

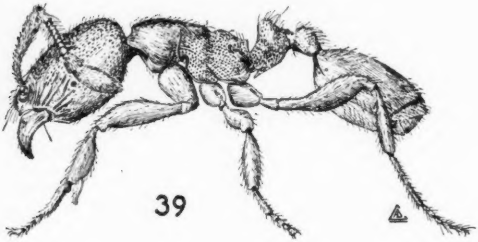
Creighton described the single female collected by Solomon Friedland at Englewood, N. J., as a new species, *friedlandi*. The author has not examined the specimen but after having reviewed the description it appears to him that at most the New Jersey individual can only be a variant of the well-known European *atratulus*. The author is also of the opinion that the host ant, *Tetramorium caespitum*, has been introduced into the United States by the early colonists.

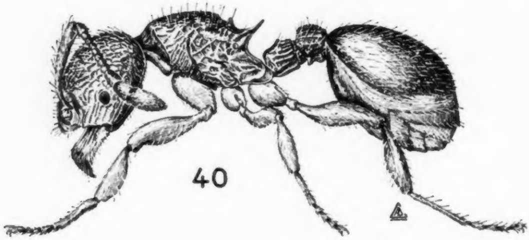
EREBOMYRMA Wheeler

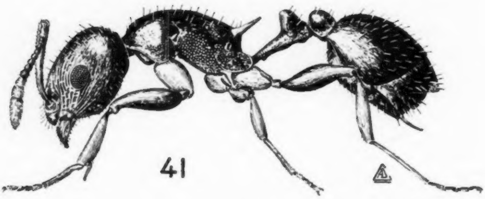
Pl. 11, Fig. 39

Erebomyrma Wheeler, 1903, Biol. Bul. **4**:138.
Genotype, *Erebomyrma longii* Wheeler (monobasic).
Wheeler, 1903, Biol. Bul. **4**:140.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 428, illus.

Length 1.5-2.25 mm. Monomorphic. Middle of anterior border of clypeus emarginate, with a tooth on each side of the emargination and a carina extending posteriorly over the clypeus from each tooth. Mandible 4-toothed. Eye extremely small, placed in the middle, or slightly anterior to the middle, of the side of the head. Antenna 11-segmented; scape short,







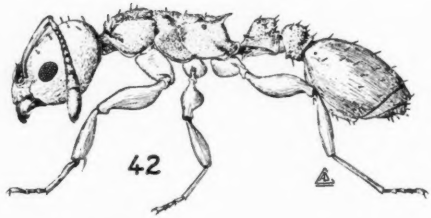


PLATE 11

Fig. 39. *Erebomyrma longii* Wheeler, worker.

Fig. 40. *Myrmecina graminicola americana* Emery, worker.

Fig. 41. *Macromischa subditiva* Wheeler, worker.

Fig. 42. *Leptothorax (Goniothorax) wilda* M. R. Smith, worker.

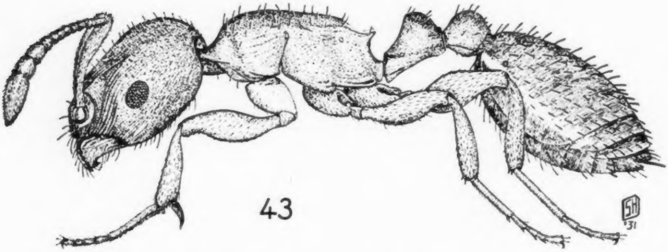
extending posteriorly only a short distance beyond the midlength of the head; funiculus with a prominent 2-segmented club, which is longer than the remaining funicular segments combined. Prothorax with rounded humeri. Promesonotal suture obsolescent or absent. Mesoepinotal region with a very strong constriction. Epinotum armed with a pair of short, tubercle-like spines which are scarcely longer than broad at the base. Petiole, in profile, distinctly larger than postpetiole. Postpetiole, from above, subcampanulate. Legs robust, femora and tibiae incrassated. Middle and hind tibiae without spurs. Mesopleura and epinotum covered with coarse, reticulate-rugose sculpturing. Body with numerous, long, yellowish hairs. Rare. One form, †*longii* Wheeler of northern Texas. Colonies nest in the soil. The ants are apparently strictly subterranean. Very little is known about their biology.

MYRMECINA Curtis

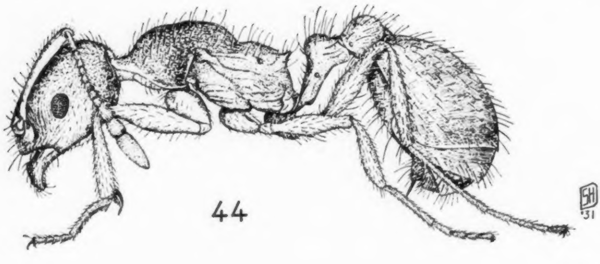
Pl. 11, Fig. 40

Myrmecina Curtis, 1829, Brit. Ent. **6**:265.
Genotype, (*Myrmecina latreillei* Curtis) = *Formica graminicola* Latreille (monobasic).
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:271.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:376.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:422.
Cole, 1940, Amer. Midl. Nat. **24**:39.
Wesson and Wesson, 1940, Amer. Midl. Nat. **24**:92.
Amstutz, 1943, Ohio Jour. Sci. **43**:169.
Buren, 1944, Iowa State Col. Jour. Sci. **18**:290.

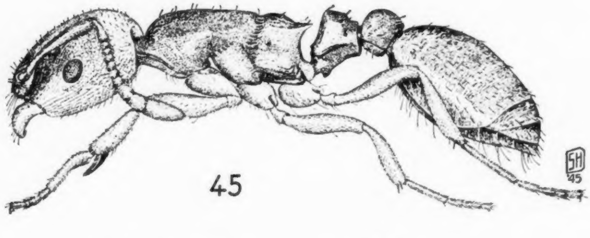
Length 2-3 mm. Head subquadrate, with deeply emarginate posterior border. Eye small, inconspicuous, placed slightly anterior to the middle of the side of the head. Antenna 12-segmented, with a distinct 3-segmented club. Anterior border of clypeus with an emarginate median lobe; portion of clypeus anterior to antennal fossa very narrow, not elevated as in *Tetramorium*. Mandibles of such shape that when closed they leave a large space between themselves and the clypeus. Maxillary palpus 4-segmented, labial palpus 3-segmented. Thorax short, stout, much broader anteriorly than posteriorly. Prothorax with well defined humeral angles. Promesonotal suture usually obsolescent. Epinotum with 2 pairs of spines, the anterior part shorter than the posterior pair. Legs rather short, with incrassated femora and tibiae; middle and hind legs without spurs. Petiole nonpedunculate. Postpetiole not very much broader than petiole, but broader and higher than long. First gastric segment occupying most of gaster. Body, exclusive of gaster, subopaque, often rather strongly sculptured, the sculpturing mostly of an irregular rugulose to rugulose-reticulate nature. Hairs simple, suberect to erect, rather abundant. Brownish to black with lighter appendages. Three forms, †*graminicola americana* Emery, †*graminicola americana brevispinosa* Emery and *graminicola texana* Wheeler. The subspecies *americana* is the most common form. Ants of this genus probably occur over the entire United States and are certainly found as far west as Arizona, California and Montana; they are apparently more common in the eastern half of the country. The small colonies occur in the ground or in rotten logs. The workers are predaceous and carnivorous. Not known to attend honeydew-excreting insects. Not rare but more uncommon than many myrmicine ants.



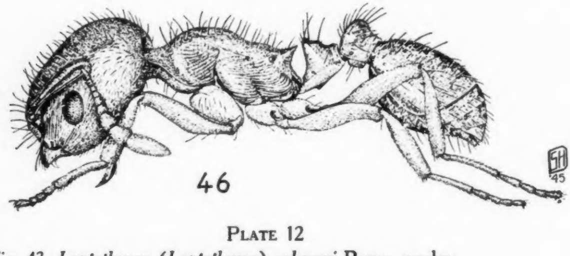
43



44



45



46

PLATE 12

Fig. 43. *Leptothorax* (*Leptothorax*) *schaumi* Roger, worker.
Fig. 44. *Leptothorax* (*Dichothorax*) sp., worker.
Fig. 45. *Leptothorax* (*Mychothorax*) *acervorum canadensis* Provancher, worker.
Fig. 46. *Harpagoxenus americanus* (Emery), worker.

MACROMISCHA Roger

Pl. 11, Fig. 41

Macromischa Roger, 1863, Berlin. Ent. Ztschr. **7**:184.
Genotype, *Macromischa purpurata* Roger (by designation of Wheeler, 1911).
Wheeler, 1903, Psyche **10**:99-100.
*Mann, 1920, Amer. Mus. Nat. Hist. Bul. **42**:409.
Wheeler, 1931, Harvard Univ. Mus. Compar. Zool. Bul. **72**:27-29.
*Smith, 1939, Ent. Soc. Amer. Ann. **32**:502-509, illus.

Monomorphic. Length 2-2.6 mm. Head usually distinctly longer than broad, with rounded posterior corners. Eye prominent to large, placed close to the middle of the side of the head. Clypeus with a median carina. Antenna 12-segmented, with a 3-segmented club; scape either short and robust or else rather long and slender. Thorax short, arched anteroposteriorly. Prothorax with rounded or subangular humeri. Promesonotal and mesoepinotal sutures faintly indicated or absent. Epinotal spines prominent. Femora incrassated, those of the posterior pair of legs very noticeably so; tibiae sometimes incrassated also. Petiole moderately to strongly pedunculate, the ventral surface with a weak to prominent tooth. Postpetiolar node broader than long. Base of gaster with prominent humeral angles. Body covered with moderately abundant to fairly abundant erect hairs. Habitus of *subditiva* and *polita* that of a *Leptothorax*, habitus of *floridana* more like that of a *Tetramorium*. Three forms, †*floridana* (Wheeler) of Florida, †*polita* M. R. Smith of Arizona, and †*subditiva* Wheeler of Texas and Louisiana. These ants form small colonies and nest largely, if not entirely, within cavities of plants.

LEPTOTHORAX, subgenus GONIOTHORAX Emery

Pl. 11, Fig. 42

Leptothorax, subg. *Goniothorax* Emery, 1896, Soc. Ent. Ital. Bol. **28**:58.
Subgenotype, *Leptothorax vicinus* Mayr (by designation of Wheeler, 1911).
Smith, 1943, Ent. Soc. Wash. Proc. **45**:154.

Antenna of 11 or 12 segments, usually with a well-defined club, the last 4 or 5 segments gradually becoming wider and longer. Pronotum more or less distinctly shouldered, the anterior angles being well-defined, often sharp, sometimes toothed. Petiole and postpetiole usually adorned with numerous tubercles or spines. Body hairs obtuse or clavate. Only one form, †*wilda* M. R. Smith of southern Texas. This has an 11-segmented antenna, with a distinct 3-segmented club. Prothorax with sharp humeral angles. Each side of thorax with 3 prominent protuberances in addition to the angular humerus, and the petiole and postpetiole each with several pairs of spines or tubercles. The ant is believed to nest in crevices of plants or trees.

LEPTOTHORAX, subgenus LEPTOTHORAX Mayr

Pl. 12, Fig. 43

Leptothorax Mayr, 1855, Zool.-Bot. Gesell. Wien, Verh. **5**:431.
Subgenotype, *Myrmica clypeata* Mayr (by designation of Emery, 1912).
Roger, 1863, Berlin. Ent. Ztschr. **7**:180.
Mayr, 1866, Sitz. Akad. Wiss. Wien **53**:508.

Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:451.
*Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:317.
*Wheeler, 1903, Phila. Acad. Nat. Sci. Proc. **55**:215, illus.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:81, 82.
Wheeler, 1913, Psyche **20**:113.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:414.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:507-511.
Smith, 1929, Ent. Soc. Amer. Ann. **22**:547-549, illus.
Smith, 1934, Psyche **41**:211-212.
Wesson, 1940, Amer. Midl. Nat. **24**:94-98.
Smith, 1942, Ent. Soc. Wash. Proc. **44**:59, illus.
Headley, 1943, Ent. Soc. Amer. Ann. **36**:743.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:286.

Length 1.5-3.3 mm. Antenna 11- or 12-segmented, with a 3-segmented club. Thoracic humeri usually rounded, occasionally subangular. Mesoepinotal impression on dorsal surface of thorax usually absent, if present, scarcely perceptible. Common. Thirty-five forms, †*andrei* Emery, †*bradleyi* Wheeler, †*curvispinosus* Mayr, †*curvispinosus ambiguus* Emery, *curvispinosus ambiguus pinetorum* Wesson and Wesson, *eldoradensis* Wheeler, †*fortinodis* Mayr, *fortinodis* var. *gilvus* Wheeler, †*fortinodis* var. *melanoticus* Wheeler, †*foveata* M. R. Smith, *furunculus* Wheeler, †*longispinosus* Roger, †*longispinosus laeviceps* Buren, *melanderi* Wheeler, *minutissimus* M. R. Smith, *neomexicanus* Wheeler, *nevadensis* Wheeler, †*nevadensis rudis* Wheeler, *nitens* Emery, †*nitens* var. *heathii* Wheeler, *nitens* var. *mariposa* Wheeler, *nitens occidentalis* Wheeler, †*obturator* Wheeler, †*rugatulus* Emery, *rugatulus annectens* Wheeler, *rugatulus brunnescens* Wheeler, *rugatulus* var. *cockerelli* Wheeler, †*rugatulus* var. *mediorufus* Wheeler, †*schaumi* Roger, *schmittii* Wheeler, †*terrigena* Wheeler, †*texanus* Wheeler, †*texanus davisi* Wheeler, †*tricarinatus* Emery, †*wheeleri* M. R. Smith. Members of this subgenus apparently occur in every state. Geographically they may be roughly divided into Eastern and Western forms, the boundary separating the two groups being approximately the 102d degree of longitude. The various forms have diverse nesting habits, their colonies occurring in the soil, wood, plant cavities, insect galls, acorns, nuts, snail shells, etc. *L. curvispinosus* and *L. longispinosus* are enslaved by *Harpagoxenus americanus* (Emery) and *L. (Mychothorax) duloticus* Wesson. The author has recently described what is believed to be a parasitic form, *L. minutissimus,* from several females collected with *curvispinosus* workers, all presumably from the same colony. The food of the workers of this subgenus appears to be honeydew and the flesh of small arthropods.

LEPTOTHORAX, subgenus DICHOTHORAX Emery

Pl. 12, Fig. 44

Leptothorax, subg. *Dichothorax* Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:323.
Subgenotype, *Leptothorax* (*Dichothorax*) *pergandei* Emery (by designation of Wheeler, 1911).
*Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:323, illus.
*Wheeler, 1903, Acad. Nat. Sci. Phila. Proc. **55**:256, illus.
Smith, 1929, Ent. Soc. Amer. Ann. **22**:549.
*Cole, 1940, Amer. Midl. Nat. **24**:58.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:286.

Length 2.5-3.25 mm. Head distinctly longer than broad, subrectangular. Eye prominent. Frontal carina short, with poorly developed lobe. Antenna 12-segmented; scape rather slender; funiculus with a 3-segmented club. Clypeus not strongly convex, usually with a weak median carina. Prothorax with rounded humeri. Promesonotal suture obsolescent or absent. Mesoepinotal constriction pronounced. Epinotum with a pair of tubercles or short spines. Legs with somewhat incrassated femora. Petiole pedunculate, the node often low, with straight, rounded or excised, transverse superior border. Postpetiole distinctly broader than long. Hairs on body simple, white or grayish, suberect to erect, long, abundant. Dorsal surface of head and pronotum smooth and shining with a coriaceous appearance. Four forms, †*pergandei* Emery, †*pergandei flavus* M. R. Smith, †*pergandei floridanus* Emery, *pergandei floridanus spinosus* M. R. Smith.. The most common of these is *pergandei.* The ants of this subgenus range from Maryland and Florida to at least Nebraska and Texas. Small colonies are formed in the soil, in rotting logs or stumps, or in debris. Workers are predaceous and carnivorous. The habitus of the worker somewhat resembles that of certain species of *Pheidole. L. (D.) manni* Wesson and *L. (D.) tennesseensis* Cole have been recently suppressed as synonyms.

LEPTOTHORAX, subgenus MYCHOTHORAX Ruzsky

Pl. 12, Fig. 45

Leptothorax, subg. *Mychothorax* Ruzsky, 1904, Fourmis, Gouv. Arkangelsk Bul. Soc. Geogr., p. 288.
Subgenotype, *Formica acervorum* Fabricius (by designation of Ruzsky, 1904).
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:318.
Wheeler, 1901, Amer. Nat. **35**:433.
*Wheeler, 1903, Acad. Nat. Sci. Phila. Proc. **55**:223-232, illus.
Wheeler, 1907, Wis. Nat. Hist. Soc. Bul. **5**:70.
Forel, 1914, Deut. Ent. Ztschr., p. 617.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:415.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:511-515.
Wesson, 1937, Ent. News **48**:125-129, illus.
Smith, 1939, Ent. Soc. Wash. Proc. **41**:176.
*Buren, Iowa State Col. Jour. Sci. **18**:286.

Length 2-3.5 mm. Antenna 11-segmented, with a 3-segmented club. Pronotum without angular humeri. Hairs on head, thorax, petiole and postpetiole suberect to erect, obtuse or clubbed (both simple and clavate in *diversipilosus*), and usually short. Mesoepinotal constriction generally distinct or pronounced. Petiole scarcely or only very slightly pedunculate. Epinotum with a pair of usually rather short, blunt spines (very long and fingerlike in *duloticus*). Gaster often with angular humeri. Clypeus sometimes with a longitudinal furrow. Eleven forms, †*acervorum canadensis* Provancher, † *acervorum canadensis calderoni* Forel, *acervorum canadensis convivialis* Wheeler, †*acervorum canadensis yankee* Emery, †*acervorum crassipilis* Wheeler, †*diversipilosus* M. R. Smith, †*duloticus* Wesson, †*emersoni* Wheeler, *emersoni glacialis* Wheeler, *hirticornis* Emery, †*muscorum* var. *sordidus* Wheeler. Mostly northern and western in distribution, probably not occurring in that section of the United States south of the 40th degree of latitude and east of the 95th degree of longitude. The ants nest in both

soil and wood. Some forms such as *emersoni* and *diversipilosus* are inquilines in the nests of other ants; the host of the former is *Myrmica brevinodis* var. *canadensis* Wheeler, that of *diversipilosus, Formica rufa obscuripes* Forel. *L. duloticus* even makes slaves of *Leptothorax curvispinosus* Mayr and *L. longispinosus* Roger. The subgenus *Mychothorax* also has individuals which are transitional between the worker and female (ergatogynes). The ergatogynes are usually distinguished from the worker by the extra sclerites of the thorax, their larger size, and the possession of ocelli. In addition to ergatogynes, *L. diversipilosus* also has an ergatander which can be distinguished from the worker by its vestigial mandibles, presence of ocelli, slender funiculus, and male genitalia. It is rather likely that *emersoni* Wheeler may prove synonymous with *provancheri* Emery.

SYMMYRMICA Wheeler

Symmyrmica Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:3.
Genotype, *Symmyrmica chamberlini* Wheeler (monobasic).
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:5, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 432, illus.
Cole, 1942, Amer. Midl. Nat. **28**:370.

Length 3-3.25 mm. Head longer than broad, with subparallel sides. Eye of moderate size, placed in middle of side of head. Small ocelli often present. Clypeus large, convex, longitudinally impressed in middle, with rounded, entire anterior border. Antennal fossa large. Frontal carinae prominent, subparallel. Maxillary palpus 5-segmented, labial palpus 3-segmented. Antenna 11-segmented; funiculus with a 3-segmented club. Thorax long, slender. Prothorax with rounded humeri. Promesontal suture faint. Mesoepinotal constriction broad, pronounced. Epinotum with a pair of short spines. Petiole not pedunculate, ventral surface with a blunt, flattened tooth. Ventral surface of postpetiole unarmed. Legs robust; femora fusiform, middle and hind tibiae without spurs. Head coarsely and densely reticulate rugose. Thorax also reticulate rugose, finely and irregularly on the pro- and mesonotum, more coarsely on the pleura and epinotum. Body and appendages covered with abundant, coarse, suberect hairs. This genus has an apterous ergatoid male with ocelli and large eyes resembling those of true males. Mandibles small, each with a single median tooth. Thorax with distinct mesonotum, paraptera, scutellum and metanotum. Antenna 12-segmented. Size approximately same as that of worker. One form, *chamberlini* Wheeler, which is an inquiline in the nest of *Myrmica mutica* Emery. Very rare. Utah. According to Wheeler this leptothoracine ant has an affinity with *Formicoxenus nitidulus* (Nylander) of Europe.

HARPAGOXENUS Forel

Pl. 12, Fig. 46

Tomognathus Mayr, 1861, Die Europäischen Formiciden, p. 56. (Preoccupied by *Agassiz*, in Dixon 1850.)
Harpagoxenus Forel, 1893, Soc. Ent. de Belg. Ann. **37**:167.
Genotype, *Myrmica sublaevis* Nylander (monobasic).
Emery, 1895, Zool. Jahrb., Abt. f. System **8**:272.

Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 494, illus.
Sturtevant, 1927, Psyche **34**:1.
Creighton, 1927, Psyche **34**:11.
Creighton, 1929, Psyche **36**:48.
Wesson, 1939, Amer. Ent. Soc. Trans. **65**:97.
Smith, 1939, Ent. Soc. Wash. Proc. **41**:165, illus.

Length 2.5-4 mm. Antenna 11-segmented; scape stout, strongly flattened, lacking a great deal of reaching the posterior border of the head; last 4 segments of the funiculus enlarged but not forming a well-defined club. Frontal carina extending to about the apex of the scape and more or less forming a scrobe for the reception of the scape. Anterior border of clypeus with a very distinct median emargination. Mandible with or without teeth. Eye prominent, placed near the middle or slightly anterior to the middle of the side of the head. Mesoepinotal impression moderately distinct to distinct. Epinotum with a pair of spines. Petiole scalelike. Postpetiole much broader than long. Gaster constricted at the base. Rare. Two forms, †*americanus* (Emery) and †*canadensis* M. R. Smith. The former is a slave-making ant on *Leptothorax curvispinosus* Mayr and *L. longispinosus* Roger, and has been collected in Virginia, New Jersey, Massachusetts, New York, Pennsylvania, Illinois, Ohio, and District of Columbia. *H. canadensis* was described from Quebec, Canada, but has also been found in Minnesota. This ant is closely allied to the European *sublaevis* Nylander. It is a slave-making form on *L. acervorum canadensis* Provancher var. In this genus there are individuals intermediate in structure between the worker and the female. These can usually be distinguished from workers by the presence of ocelli and by the extra sclerites of the thorax. For detailed accounts of the biology and slave-making habits of *americanus* see Creighton and Sturtevant, 1927, and Wesson, 1939.

TRIGLYPHOTHRIX Forel

Pl. 13, Fig. 47

Triglyphothrix Forel, 1890, Soc. Ent. de Belg. Ann., Compt. Rend. **34**:cvi.
Genotype, *Triglyphothrix walshi* Forel (monobasic).
Emery, 1889, Mus. Stor. Nat. Genova, Ann. (2) **7**:501.
*Bingham, 1903, Fauna British India Hymen. **2**:173.
Wheeler, 1916, Jour. Econ. Ent. **9**:566, illus.

Length 2.5 mm. Posterior border of clypeus forming a distinct ridge or carina in front of each antennal insertion. Head subrectangular. Frontal carinae well-separated, greatly extended posteriorly to form scrobes for the reception of the antennal scapes. Eye prominent. Antenna 12-segmented; funiculus with a 3-segmented club. Thorax short, stout, strongly arched dorsally, without promesonotal and mesoepinotal sutures. Epinotum with a pair of long, pointed spines and a pair of metasternal spines. Petiole, in profile, pedunculate, with a somewhat subrectangular node. Head and thorax rugulose reticulate. Body covered with dense, soft, erect hairs, many of which are branched or trifid. One form, †*striatidens* (Emery), an apparently introduced Indian ant, has been found in several towns in Florida, South Carolina, Alabama, Mississippi, and Louisiana. Colonies nest in the soil. Wheeler, 1916, indicates that the ant may be expected to become established in green-

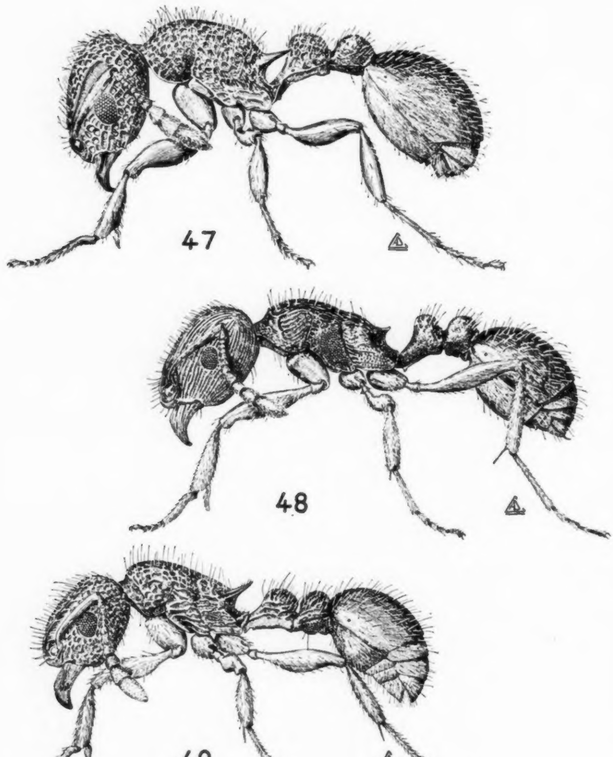


PLATE 13

Fig. 47. *Triglyphothrix striatidens* (Emery), worker.
Fig. 48. *Tetramorium caespitum* (Linnaeus), worker.
Fig. 49. *Xiphomyrmex spinosus insons* Wheeler, worker.
Fig. 50. *Wasmannia auropunctata* (Roger), worker.

houses, especially in the more northern regions of our country. Although little is known of the biology of this species the workers no doubt attend honeydew-excreting insects.

TETRAMORIUM Mayr

Pl. 13, Fig. 48

Tetramorium Mayr, 1855, Zool.-Bot. Gesell. Wien, Verh. **5**:423.
Genotype, *Formica caespitum* Linnaeus (by designation of Girard, 1879).
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:973, 976.
*Bingham, 1903, Fauna British India Hymen. **2**:176, 184.
*Emery, 1909, Deut. Ent. Ztschr. **6**:695, 699, illus.
Santschi, 1909, Soc. Ent. Ital. Bol. **41**:6.
Smith, 1915, Va. Truck Crop Expt. Sta. Bul. **16**:1-15, illus.
Forel, 1923, Suisse Zool. Rev. **30**:91.
Donisthorpe, 1927, British Ants, Geo. Routledge and Sons, London, 2d ed., p. 189, illus.
*Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:831, 851, 853.
*Metcalf and Flint, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., p. 770.
*Smith, 1943, Ent. Soc. Wash. Proc. **45**:1-5, illus.

Length 1.75-4.25 mm. Posterior border of clypeus forming a distinct ridge or carina in front of each antennal socket. Frontal carinae well-separated, often greatly extended posteriorly to form scrobes for the reception of the antennal scapes. Eye prominent, placed very near the middle of the side of the head. Antenna 12-segmented; funiculus with a 3-segmented club. Prothorax of most species with angular humeri. Promesonotal suture usually indistinct or absent. Mesoepinotal region usually with a weak to strong impression or constriction. Epinotum with a pair of short or long spines. Metasternum usually extended posteriorly as a pair of spines or tubercles. Femora and tibiae incrassated in some species. Clypeus usually with a number of prominent longitudinal carinae. Sculpturing of head and thorax largely striate, rugulose, or rugulose reticulate. Hairs usually simple, though sometimes enlarged apically. Seven forms, *bahai* Forel, †*caespitum* (Linnaeus), †*guineense* (Fabricius), †*pacificum* Mayr var., †*rugiventris* M. R. Smith, *silvestrii* Santschi, and †*simillimum* (F. Smith). All but *bahai, rugiventris,* and *silvestrii* are found in greenhouses and nurseries, or in and around urban communities, especially in the southern and eastern half of the United States. The four apparently introduced forms, *caespitum, guineense, pacificum* var. and *similimum* are of considerable economic importance. The best known of these is *caespitum* which gnaws into the roots and bases of vegetables and flowers, steals seeds from seed beds, infests houses, and attends honeydew-excreting insects. It is also the host of the well-known parasitic ant, *Anergates atratulus* (Schenck). For further information on the relation of the two see remarks under *Anergates*, p. 571. *T. bahai,* described by Forel from specimens supposedly collected at Faisons, N. C., and *T. silvestri,* described by Santschi from Tucson, Ariz., have not been recognized since the time of their original description. It is the author's opinion that all forms authentically recorded for the United States were probably introduced.

XIPHOMYRMEX Forel

Pl. 13, Fig. 49

Tetramorium, subg. *Xiphomyrmex* Forel, 1887, Schweiz. Ent. Ges. Mitt. **7**:385.
Genotype, *Tetramorium* (*Xiphomyrmex*) *kelleri* Forel (by designation of Wheeler, 1911).
Pergande, 1895, Calif. Acad. Sci. Proc. **5**:894.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:128.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:415.
*Smith, 1938, Wash. Acad. Sci. Jour. **28**:126, illus.

Length 3.2-4 mm. Habitus somewhat similar to that of *Tetramorium guineense* (Fabricius). Hairs simple, either long, or else short and somewhat coarse. Characters similar to those of *Tetramorium* except for the 11-segmented antenna. Sculpturing mostly rugulose reticulate. Habitat very warm, dry, open regions. Two forms, †*spinosus hispidus* Wheeler of the desert region around Tucson and Phoenix, Ariz., and †*spinosus insons* Wheeler from localities in Texas and Arizona. Uncommon. The ants form small colonies in the ground.

Wheeler (1915) stated that he collected in the Huachucha Mountains of Arizona a *Xiphomyrmex* closely related to *spinosus wheeleri* Forel. Forel's form was described from Mexican specimens.

WASMANNIA Forel

Pl. 13, Fig. 50

Wasmannia Forel, 1893, London Ent. Soc. Trans., p. 383.
Genotype, *Tetramorium auropunctatum* Roger (by designation of Wheeler, 1911).
Roger, 1863, Berlin. Ent. Ztschr. **7**:182.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:143, illus.
Smith, 1929, Jour. Econ. Ent. **22**:241.
Wheeler, 1929, Psyche **36**:89.
*Smith, 1939, Puerto Rico Univ. Jour. Agr. **20**: 854, illus.
Spencer, 1941, Fla. Ent. **24**:6.

Length approximately 1.5 mm. Antenna 11-segmented; scape not extending past the posterior border of the head; funiculus with a 3-segmented club, the last segment of which is very large and prominent and is considerably longer than the 2 preceding segments combined. Frontal carina extending almost to the posterior border of the head and forming a more or less distinct scrobe for the reception of the scape. Eye rather prominent, very coarsely faceted, the border nearest the mandible forming a rather acute point which is directed anteroventrally. Prothorax with angular humeri. Promesonotal suture obsolescent or absent. Epinotal spines prominent, closely placed basally. Petiolar node, in profile, subrectangular. Hairs on body long, sparse. General color golden brown. One form, †*auropunctata* (Roger), which has apparently been introduced into a number of localities in Florida. The ants nest in both soil and wood. The colonies are usually very populous. *W. auropunctata* is of considerable economic importance because of the painful, long-lasting stings of the workers, its house-infesting habits and attendance on honeydew-excreting insects. For an account of the biology and economic importance of this ant under Florida conditions, see Spencer 1941.

CRYPTOCERUS, subgenus CRYPTOCERUS Fabricius

Pl. 14, Fig. 51

Cryptocerus Fabricius, 1804, Syst. Piez., p. 418.
Subgenotype, *Cryptocerus umbraculatus* Fabricius (by designation of Emery, 1914).
Santschi, 1915, Soc. Ent. de France Bul. **13**:208, illus.
Wheeler, 1916, New Engl. Zool. Club Proc. **6**:32, illus.

Dimorphic. Length 3.5-6 mm. Body rather depressed. Frontal carinae distant, continuing backward above eyes on sides of head, each forming a prominent, more or less horizontal lobe under which the entire antenna can be concealed. Antenna 11-segmented, enlarged apically, but without a well-defined club. A scrobe for the reception of the antenna lying anterior to the eye and beneath the lobe of the frontal carina. Eye well-developed, convex, placed closer to the posterior corner of the head; exposed in the worker, more concealed in the soldier. Part of mandible including the masticatory margin exposed. Dorsal surface of head of soldier with a somewhat saucer-shaped structure, with the rim broken or interrupted anteriorly and very poorly formed posteriorly. Each side of thorax marginate and bearing a number of irregular spines or tubercles. Soldier with a prominent, interrupted, transverse ridge, anterior to the promesonotal suture; also with rather distinct promesonotal and mesoepinotal sutures. Legs short, femora incrassated. Petiole and postpetiole each with prominent spines on the side. Gaster oval, usually with a rather deep basal emargination where the postpetiole is attached to the gaster. Body clothed with short, closely appressed, silvery or grayish hairs. Two forms, †*rohweri* Wheeler of Arizona, and †*texanus* Santschi of Texas. The ants form small colonies in cavities within trees and plants, especially dead branches. Some colonies even nest in insect galls. Very little is known of their biology. Wheeler 1916, page 35, states that he had referred to *angustus* Mayr specimens taken at Brownsville, Tex., by Mr. Charles Schaeffer which are apparently the same form as Santschi's *texanus*.

CRYPTOCERUS, subgenus CYATHOMYRMEX Creighton

Pl. 14, Fig. 52

Cryptocerus, subg. *Cyathocephalus* Emery, 1915, Soc. Ent. de France Bul., p. 192. (*Cyathocephalus* preoccupied by Kessler,, 1868.)
Cyathomyrmex Creighton, 1933, Psyche **40**:98.
Subgenotype, *Cryptocerus pallens* Klug (by original designation).
F. Smith, 1876, Lond. Ent. Soc. Trans., p. 606, illus.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:102, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., pp. 17, 90, 151, 426, illus.

Dimorphic. Length 3-6 mm. Characters similar to those of the subgenus *Cryptocerus* except that the saucer-shaped structure on the head of the soldier is completely rimmed, and deep within (concave), the mandibles are concealed, and the gaster is noticeably elongate. The worker differs mainly in its elongate gaster. One form, †*varians* F. Smith of Florida. Nesting habits similar to those of the subgenus Cryptocerus.

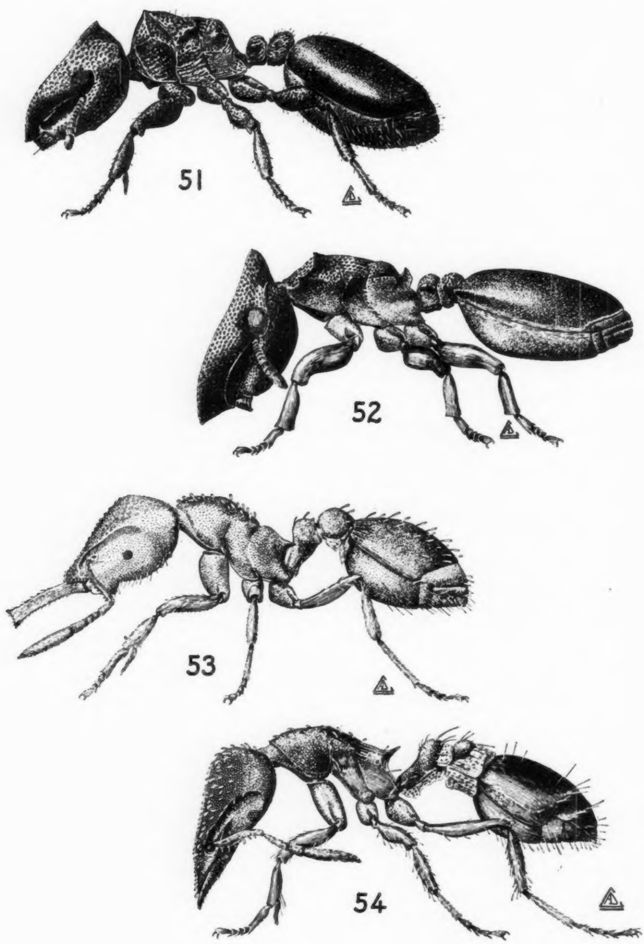


PLATE 14

Fig. 51. *Cryptocerus* (*Cryptocerus*) *rohweri* Wheeler, soldier.
Fig. 52. *Cryptocerus* (*Cyathomyrmex*) *varians* F. Smith, worker.
Fig. 53. *Strumigenys* (*Strumigenys*) *louisianae laticephala* M. R. Smith, worker.
Fig. 54. *Strumigenys* (*Trichoscapa*) *rostrata* Emery, worker.

STRUMIGENYS, subgenus STRUMIGENYS F. Smith

Pl. 14, Fig. 53

Strumigenys F. Smith, 1860, Jour. Ent. **1**:72 (London).
Subgenotype, *Strumigenys mandibularis* F. Smith (monobasic).
Roger, 1863, Berlin. Ent. Ztschr. **7**:211.
*Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:326.
*Smith, 1931, Ent. Soc. Amer. Ann. **24**:688-691, illus.
Creighton, 1937, Psyche **44**:97, illus.

Monomorphic. Length 2.25-2.5 mm. Head subcordate, with strongly emarginate posterior border and prominent, rounded posterior corners. Anterior border of clypeus subtruncate. Mandibles placed close to each other on anterior border of head, slender, porrect, subparallel (somewhat like *Odontomachus*), longer than half of the remainder of the head; each with a preapical tooth and 2 large apical teeth. Antenna 6-segmented, with an extremely long apical segment which is longer than the remaining segments of the funiculus combined, and approximates the length of the scape. A rather well-defined scrobe above the eye for the reception of the scape. Eye unusually well-developed. Promesonotal suture obsolescent or absent. Mesoepinotal constriction distinct. Epinotum with a pair of short spines and an infraspinal lamella beneath each. Petiolar and postpetiolar nodes broader than long, the latter unusually broad. Postpetiole with spongiform processes on its ventral and posterior borders. Base of first gastric segment with longitudinal striae in addition to the reticulation. Head densely, thorax less densely, covered with short, depressed, scalelike hairs; petiole, postpetiole and gaster with longer and more erect, clavate hairs. Two forms, †*louisianae* Roger and †*louisianae laticephala* M. R. Smith. Members of this subgenus have been recorded from North Carolina, Tennessee and Florida westward into Louisiana, Arkansas, Texas and Arizona. The forms appear to be mainly southern in distribution. Small colonies are found nesting in the soil and in logs and stumps. Creighton 1937 presents data to indicate that the ants of this subgenus are at least partly insectivorous.

STRUMIGENYS, subgenus TRICHOSCAPA Emery

Pl. 14, Fig. 54

Cephaloxys F. Smith, 1865, Linn. Soc. Lond. Jour. Zool. **8**:76. (Preoccupied by Signoret, 1847.)
Genotype, *Cephaloxys capitata* F. Smith (monobasic).
Strumigenys, subg. *Trichoscapa* Emery, 1869, Accad. degli Aspiranti Naples, Ann. (2) **2**:24.
Subgenotype, *Strumigenys* (*Trichoscapa*) *membranifera* Emery (monobasic).
*Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:325, illus.
*Smith, 1931, Ent. Soc. Amer. Ann. **24**:686, illus.
Kennedy and Schramm, 1933, Ent. Soc. Amer. Ann. **26**:95, illus.
Wheeler, 1933, Hawaii Ent. Soc. Proc. **8**:275, illus.
Weber, 1934, Psyche **41**:63, illus.
Smith, 1935, Ent. Soc. Amer. Ann. **28**:214.
Wesson, 1936, Ent. News **47**:171.
*Wesson and Wesson, 1939, Psyche **46**:91, illus.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:290.

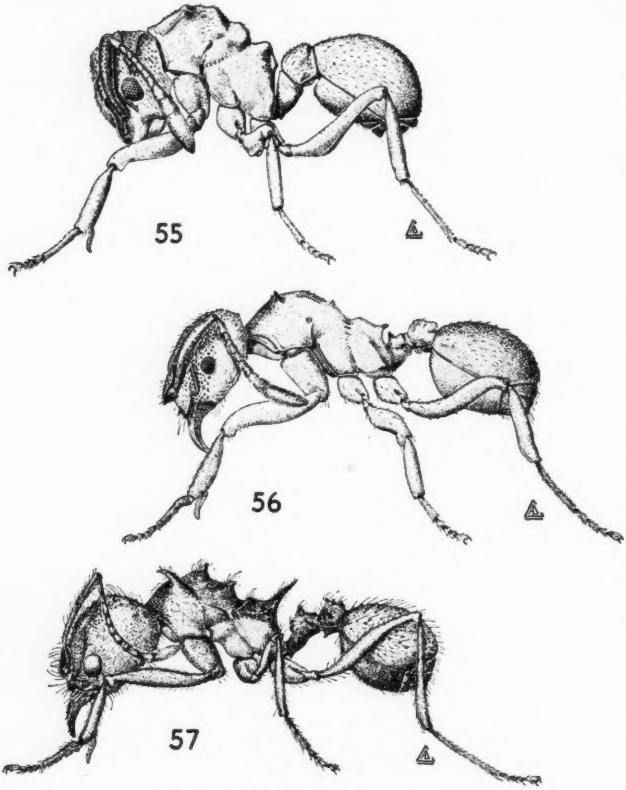


PLATE 15

Fig. 55. *Cyphomyrmex* (*Cyphomyrmex*) *rimosus minutus* Mayr, worker.
Fig. 56. *Cyphomyrmex* (*Mycetosoritis*) *hartmanni* Wheeler, worker.
Fig. 57. *Acromyrmex* (*Moellerius*) *versicolor* (Pergande), major worker.
Fig. 58. *Atta texana* Buckley, major worker.

Monomorphic. Length 1.3-2.5 mm. Most forms smaller than in the subgenus *Strumigenys*. Head very variable in shape, narrower anteriorly than posteriorly, with emarginate posterior border and prominent rounded or angular posterior corners. Antenna 6-segmented, the last segment very long and usually as long as, or longer than, the remaining funicular segments combined; scape sometimes angular at the base. Eye varying from extremely small to rather well-developed. Clypeus of diverse shape, with subtruncate, rounded or acutely pointed anterior border. Mandible much shorter than in the subgenus *Strumigenys*, usually not as long as clypeus and generally of a subtriangular shape, but with diverse dentition. Spongiform processes on petiole and postpetiole sometimes very highly developed. Pilosity variable with regard to length, shape and abundance, most often spatulate or clavate; often the hairs on the clypeus and antennal scape are very characteristic with regard to position and shape. Base of gaster usually wtih longitudinal striae. Twenty-five forms, *abdita* Wesson and Wesson, †*angulata* M. R. Smith, *bimarginata* Wesson and Wesson, †*clypeata* Roger, *clypeata* var. *brevisetosa* M. R. Smith, †*clypeata* var. *laevinasis* M. R. Smith, †*clypeata* var. *pilinasis* Forel, †*creightoni* M. R. Smith, †*dietrichi* M. R. Smith, †*manni* Wesson and Wesson, †*margaritae* Forel, *medialis* Wesson and Wesson, *membranifera* var. *marioni* Wheeler, †*membranifera simillima* Emery, †*missouriensis* M. R. Smith, *ohioensis* Kennedy and Schramm, †*ornata* Mayr, †*pergandei* Emery, †*pulchella* Emery, †*reflexa* Wesson and Wesson, †*rohweri* M. R. Smith, †*rostrata* Emery, †*sculpturata* M. R. Smith, *talpa* Weber, *venatrix* Wesson and Wesson. Members of this subgenus no doubt occur in all states east of the Mississippi River except perhaps Maine, Vermont, New Hampshire, Michigan and Wisconsin. West of the Mississippi their distribution is imperfectly known but the ants have been collected in Louisiana, Texas, Missouri and California. The various forms nest in the soil and also in rotten wood such as logs and stumps. The colonies are small. Wesson found that several species are predaceous on springtails. Kennedy suggested that the workers may feed on fungi.

CYPHOMYRMEX, subgenus CYPHOMYRMEX Mayr

Pl. 15, Fig. 55

Cyphomyrmex Mayr, 1862, Zool.-Bot. Gesell. Wien, Verh. **12**:690.
Subgenotype, *Cryptocerus rimosus* Spinola (by designation of Wheeler, 1911).
Mayr, 1862, Zool.-Bot. Gesell. Wien, Verh. **12**:691.
Forel, 1900, Mitt. Schwiez. Ent. Gesell. **10**:282.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:106, illus.
Wheeler, 1907, Amer. Mus. Nat. Hist. Bul. **23**:719, 722, 725, 765-773, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 333, illus.
Smith, 1936, N. Y. Ent. Soc. Jour. **44**:166.
*Weber, 1940, Rev. de Ent. **11**:408.

Monomorphic. Length 1.8-2.5 mm. Antenna 11-segmented. Frontal widely separated, posteriorly divergent, extending approximately to the posterior corners of the head and each forming a scrobe for the reception of the scape; each carina also forming anteriorly a very large lobe which conceals the insertion of the antenna. Eye prominent, rather strongly convex, placed approximately in the middle of the side of the head. Posterior border of head emarginate, the corners extended as weak to strong earlike lobes. Vertex

of head with 2 small, often blunt carinae lying between the earlike lobes. Carina near inner border of eye extending posteromesially. Thorax short, stout, with a number of dorsal elevations which are either blunt tubercles or more or less longitudinally directed carinae. Body covered with short, but not dense, very closely appressed, scalelike hairs. Apparently no erect hairs dorsally. Epinotum with a pair of distinct spines or with a pair of very short, vestigial tubercles. Three forms, †*rimosus* var. *comalensis* Wheeler of Texas, †*rimosus minutus* Mayr of Florida, and †*wheeleri* Forel which occurs from Texas westward into California. The members of this subgenus form small colonies in the ground. According to Wheeler 1907, page 765, *wheeleri* in Texas occurs only in arid regions. The other forms, especially *minutus*, seem to require more humid conditions. Like other Attini these ants feed on a fungus which they cultivate in their nests.

CYPHOMYRMEX, subgenus MYCETOSORITIS Wheeler

Pl. 15, Fig. 56

Atta, subg. *Mycetosoritis* Wheeler, 1907, Amer. Mus. Nat. Hist. Bul. **23**:714.
Subgenotype, *Atta* (*Mycetosoritis*) *hartmanni* Wheeler (monobasic).
Wheeler ,1907, Amer. Mus. Nat. Hist. Bul. **23**: 714-717, 761, illus.
Emery, 1913, Soc. Ent. de Belg. Ann. **57**:251.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 334, illus.

Monomorphic. Length 1.8-2 mm. Posterior border of head with a strong, angular emargination. Posterior corners with a well-defined angle. Antenna 11-segmented; scape robust, last funicular segment unusually large, as long as, or longer than, the 4 preceding segments. Frontal carinae widely separated, each with a very large horizontal lobe the anterolateral angle of which is very acute. A carina near the inner border of the eye extending posteromesially a slight distance beyond the eye. Inferior angle of prothorax without a spine. Pronotum with a pair of rather prominent humeral spines and a pair of small tubercles between them. A pair of converging ridges extending through the mesonotum toward the strong mesoepinotal constriction. Epinotum with a pair of short spines. Node of petiole above with a pair of spines. Postpetiole much broader than long, the posterior border emarginate. Front and vertex of head longitudinally rugulose. Hairs short, curved, more erect on head. Only one form of these fungus ants, †*hartmanni* Wheeler of Texas and western Louisiana. These ants form small colonies in the soil. The entrances to their nests are usually one or more turriform craters. For information on biology see Wheeler, 1907, pages 761-765. The ants of this subgenus have some characters in common with both *Trachymyrmex* and *Cyphomyrmex*. They are considered here as a subgenus of *Cyphomyrmex* because of their small size, unusually large frontal carinae, reduction of spines on the body, and the absence of tubercles over most of the body (gaster with very minute tubercles).

TRACHYMYRMEX Forel

Pl. 16, Fig. 59

Atta, subg. *Trachymyrmex* Forel, 1893, Soc. Ent. de Belg. Ann. **37**:600.
Genotype, *Atta septentrionalis* McCook (by designation of Wheeler, 1911).

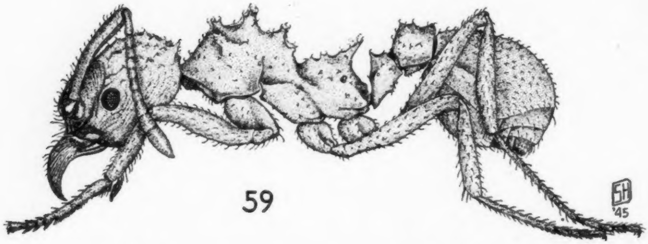
McCook, 1880, Acad. Nat. Sci. Phila. Proc., p. 359.
Wheeler, 1903, Psyche **10**:100, illus.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:386.
Wheler, 1907, Amer. Mus. Nat. Hist. Bul. **23**:706-712, 746-759, illus.
Wheeler, 1911, Psyche **18**:93, 98, illus.
*Wheeler, 1911, N. Y. Ent. Soc. Jour. **19**:245-250.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 335, illus.

Monomorphic. Length 2.5-4 mm. Antenna 11-segmented, without a well-defined club. Eye convex, placed anterior to the middle of the side of the head. Frontal carinae diverging posteriorly, extending almost to the posterior border of the head; each carina with a prominent, sometimes angular, lobe covering the antennal insertion. A carina near the inner border of the eye extending either posteriorly or posteromesially. Mandibles crossing, each mandible with a long masticatory border. Anterior border of clypeus with a distinct emargination. Posterior border of head, especially the occipital lobes, with numerous tubercles. Inferior angle of prothorax with a spine. Pronotum with a pair of lateral, tubercle-covered spines, and usually a pair of short spines between them. Mesonotum with 2 pairs of prominent, tubercle-covered spines. Mesoepinotal constriction prominent. Epinotum with the usual par of spines and a tubercle-covered carina leading to each spine. Petiole, postpetiole and gaster with numerous tubercles, each of which bears a short, curved hair. Femora and tibiae with very small tubercles, each bearing a short, curved hair. Body often covered with a grayish substance which is occasionally of a granular nature. Spines on the promesonotum extremely variable in shape, sharp or blunt, with few or no tubercles on them. Ten forms, †*arizonensis* Wheeler, †*desertorum* Wheeler, †*septentrionalis* (McCook), †*septentrionalis obscurior* Wheeler, †*septentrionalis obscurior crystallina* Wheeler, †*septentrionalis obscurior irrorata* Wheeler, *septentrionalis obscurior seminole* Wheeler, *septentrionalis* var. *vertebrata* Wheeler, †*turrifex* Wheeler, *turrifex caroli* Wheeler. The forms east of the Mississippi River are *septentrionalis,* or variants of it, and occur more or less south of a line running from southern Illinois to southeastern New York; west of the river no forms of *Trachymyrmex* have been reported in any of the states entirely north of the 35th degree of latitude, nor have any been recorded from California. The small colonies nest in the soil. Although able to cut leaves the workers do not resort to this habit so consistently as do species of *Atta* and *Acromyrmex*. Like other *Attini* these ants feed largely, if not entirely, on the fungus which they cultivate in their nests. For information on biology see Wheeler, 1907, pages 746-759.

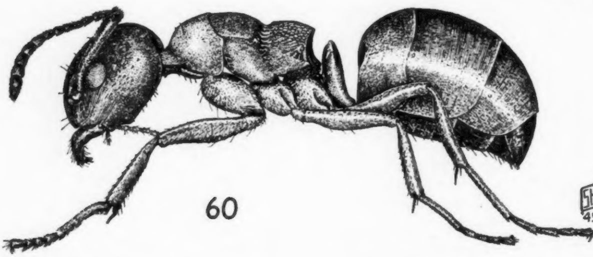
ACROMYRMEX, subgenus MOELLERIUS Forel

Pl. 15, Fig. 57

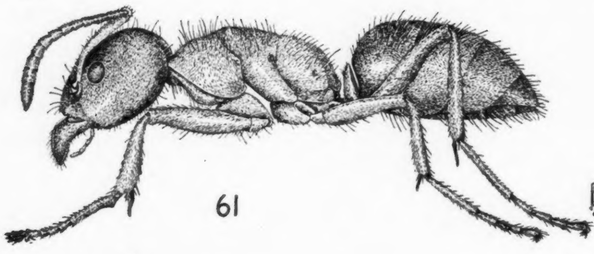
Atta, subg. *Moellerius* Forel, 1893, Soc. Ent. de Belg. Ann. **37**:589.
Subgenotype, *Atta* (*Acromyrmex*) *landolti* Forel (by designation of Wheeler, 1911).
Pergande, 1893, Calif. Acad. Sci. Proc. (2) **4**:31.
Wheeler, 1907, Amer. Mus. Nat. Hist. Bul. **23**:703, 743, illus.
*Santschi, 1925, Rev. Suisse Zool. **31**:389.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 337, illus.



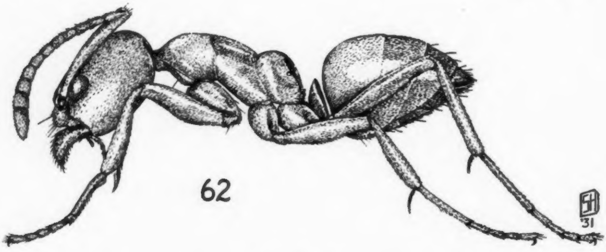
59



60



61



62

PLATE 16

Fig. 59. *Trachymyrmex septentrionalis obscurior seminole* Wheeler, worker.
Fig. 60. *Dolichoderus (Hypoclinea) taschenbergi* Mayr, worker.
Fig. 61. *Liometopum occidentale* Emery, worker.
Fig. 62. *Iridomyrmex humilis* Mayr, worker.

Feebly polymorphic. Length 2.3-6 mm. Head subcordate. Frontal carina with a lobe covering the antennal insertion; the lobe with a pair of spines or tubercles posteriorly. A longitudinal carina near the inner border of the eye extending slightly posteromesially. Clypeus with a distinct but not very strong emargination. Antenna 11-segmented, without a well-defined club. Eye rather strongly convex, placed anterior to the middle of the side of the head. Mandible with the external margin not distinctly sinuate. Postocular spine absent or poorly developed. Occipital lobe with a number of spines or tubercles, one of which is much larger than the others. Thorax dorsally with at least 4 pairs of spines; 1 pair on pronotum, pairs on mesonotum, and the usual pair on epinotum; inferior angle of prothorax with a spine. Postpetiole and dorsal surface of gaster with many well-developed tubercles or spines. Two forms, †*versicolor* (Pergande) of Arizona and its subspecies *chisosensis* Wheeler of Texas. The former, at least, is an arid-area ant which extends from Mexico into Arizona. Like *Atta texana* Buckley it is a soil-nesting and plant-defoliating form. According to Wheeler the colonies are not as large as are those of *texana* and the characteristic earthen craters are ordinarily not so numerous. For an account of the biology see Wheeler, 1907, pages 743-746.

ATTA Fabricius

Pl. 15, Fig. 58

Atta Fabricius, 1804, Syst. Piez., p. 421.
Genotype, *Formica cephalotes* Linnaeus (by designation of Wheeler, 1911).
Buckley, 1860, Acad. Nat. Sci. Phila. Proc. **12**:233.
Buckley, 1867, Ent. Soc. Phila. Proc. **6**:347.
Wheeler, 1907, Amer. Mus. Nat. Hist. Bul. **23**:700, 729, illus.
*Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 337.
Walter, 1938, U. S. Dept. Agr. Circ. 494: 1, illus.
Smith, 1939, Southern For. Expt. Station, Occ. Paper 84: 1, illus.
*Goncalves, 1942, Soc. Brazil de Agron. Bol. **5**:335, illus.

Polymorphic. Length 1.5-12 mm. Head subcordate. Antenna 11-segmented, without a well-defined club. Eye rather strongly convex, placed anterior to the middle of the side of the head. Anterior border of clypeus with a distinct emargination and a tooth on each side of the emargination. Mandible large, flattened, with long masticatory border bearing numerous teeth. Frontal carina with a lobe covering the antennal insertion, and a spine posterior to the lobe. A longitudinal carina median to the eye ending below in a small spine or tubercle. A short spine on each occipital lobe and a long spine on each posterior corner of the head. Thorax with 3 pairs of prominent dorsal spines and a small spine on each inferior angle of the prothorax. Legs unusually long. Gaster without tubercles. Spines of larger workers more pronounced and in addition there is usually an impressed area dorsally on each side of the base of the gaster. One form, †*texana* Buckley of Texas and western Louisiana, which forms large and conspicuous nests in the soil. These nests contain innumerable individuals. The Texas leaf-cutting ant is an important economic species because of the damage it inflicts on domesticated plants, its house-infesting habits, and the injury caused to roads by the mining of the soil. For a biological account see Wheeler 1907, pages 729-743.

Subfamily Dolichoderinae Forel

Dolichoderidae Forel, 1878, Ztschr. Wiss. Zool. **30**:54.
Dolichoderinae Dalla Torre, 1893, Catal. Hymen. **7**:156.

Cloacal orifice ventral, slit-shaped. Pedicel composed of a single segment, the petiole. No constriction between the first and second gastric segments. Sting rudimentary or absent. Anal glands present which produce a secretion with a characteristic, disagreeable odor. Clypeus extended back between the frontal carinae. Antennal fossa touching the posterior border of the clypeus. Antenna 12-segmented; funiculus without a club. Body usually weakly sculptured. Eye well-developed, situated well toward the median line of the head. Masticatory border of mandible often with many small teeth or denticulae. Body hairs sparse on workers in many of the genera. Pubescence sometimes very dense and imparting to certain sections of the body a characteristic grayish or ashy tinge. Pupae naked. Monomorphic. This, one of our smaller subfamilies, contains 27 forms. Although representatives occur in every state more forms are found in the South than elsewhere. Colonies usually contain from a few hundred to a few thousand individuals. Nests, though commonly constructed in the soil, may also be made in rotten wood, crevices in trees and plants or other places. Honeydew and the flesh of small arthropods comprise the food of most of the members of this group. Many of the forms infest houses, the Argentine ant, *Iridomyrmex humilis* Mayr, being one of the best known of these.

The genus *Bothriomyrmex* Emery is not known to occur in the United States. The species *dimmocki* described by Wheeler from specimens collected from Mount Tom near Springfield, Mass. (1915, Amer. Mus. Nat. Hist. Bul. **34**:417), has been shown by Emery (1925, Soc. Vaud. Sci. Nat. Bul. **56**:19) to be a true *Tapinoma.* As Emery points out, Wheeler's specimens have 6 segments in the maxillary palpus, and a vestigial petiolar scale which clearly proves them to be a form of *Tapinoma. Bothriomyrmex* has 4 segments in the maxillary palpus and a distinct petiolar scale. Although the author has not seen workers of *dimmocki* it seems quite likely that they may be only a pale, depauperate form of the common *sessile* (Say), which is a highly adaptable species ranging from the sands of the seashore to an altitude of 10,000 feet.

1. Epinotal declivity strongly concave. Integument stiff, brittle. At least the epinotum usually more or less coarsely sculptured. (Mesoepinotal constriction pronounced. Color often striking.) Pl. 16, fig. 60 .... *Dolichoderus,* subgenus *Hypoclinea* Mayr, p. 593

   Epinotum declivity not as described. Integument thin, flexible. Epinotum as well as remainder of body finely sculptured 2

2. (1) Epinotum with a prominent conical or tubercular elevation. Maxillary palpus unusually long, the third segment approximately as long as the combined lengths of the fourth, fifth and sixth segments. Ventral surface of head usually with a weakly developed psammophore. Pl. 17, fig. 64 .... *Dorymyrmex,* subgenus *Conomyrma* Forel, p. 597

   Not as described above 3

3. (2) Petiolar node vestigial. (Base of gaster extended above the petiole.) Pl. 17, fig. 65 .... *Tapinoma,* Förster, p. 598

Petiolar node not vestigial, although sometimes small, low, and difficult to see 4

4.(3) Ocelli usually present in at least the large workers. Gaster clothed with a very dense, grayish pubescence which often conceals the surface and imparts a characteristic grayish or ashy tinge. Anterolateral angles of the clypeus somewhat protuberant. Petiolar scale with a rather pointed and often thin, superior border. Thorax, in profile, without a conspicuous impression before the epinotum, the dorsal surface therefore forming somewhat of an uninterrupted arch. Known only from Texas, New Mexico, Arizona, Colorado, California and Oregon. Pl. 16, fig. 61 .... *Liometopum* Mayr, p. 594

Ocelli absent. Other characters not as described 5

5. (4) Scale of the petiole small, low, inclined. Scapes and tibiae with erect hairs. Proventriculus with a convex, 4-lobed calyx. Entirely native. Texas; also recorded from some of the southwestern states. Pl. 17, fig. 63 .... *Forelius* Emery, p. 595

Scale of the petiole well-developed although usually inclined. Scapes and tibiae without erect hairs. Proventriculus not as described. Introduced and native forms. The native forms largely confined to the southern states. Pl. 16, fig. 62 .... *Iridomyrmex* Mayr, p. 594

DOLICHODERUS, subgenus HYPOCLINEA Mayr

Pl. 16, Fig. 60

Hypoclinea Mayr, 1855, Zool.-Bot. Gesell. Wien, Verh. **5**:377.
Subgenotype, *Formica quadripunctata* Linnaeus (by designation of Wheeler, 1911).
Mayr, 1866, Sitz. Akad. Wiss. Wien **53**:498.
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:953-961.
Forel, 1884, Soc. Vaud. des Sci. Nat. Bul. **20**:349.
*Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:434.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:304.
*Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:305, illus.
Wheeler, 1916, Ind. Acad. Sci. Proc. **26**:460.
Cole, 1940, Amer. Midl. Nat. **24**:60.
Wesson and Wesson, 1940, Amer. Midl. Nat. **24**:99.

Length 2.75-4.5 mm. Integument stiff, somewhat brittle and often rather strongly sculptured, especially on the head and thorax. No ocelli. Antenna 12-segmented. Antennal fossa touching the posterior border of the clypeus. Eye situated well toward the median line of the head. Promesonotal suture distinct. Mesoepinotal constriction strongly pronounced. Declivous surface of epinotum strongly concave. Petiole scalelike, inclined, often thick anteroposteriorly and with blunt superior border. Base of gaster not extended above petiole. Cloacal orifice inferior. Hairs and pubescence sparse in some species. Color of body very striking in some forms. Nine forms, †*mariae* Forel, †*mariae* var. *blatchleyi* Wheeler, †*mariae davisi* Wheeler, †*plagiatus* Mayr, †*plagiatus pustulatus* Mayr, †*plagiatus pustulatus beutenmuelleri* Wheeler, †*plagiatus* var. *inornatus* Wheeler, †*taschenbergi* Mayr, †*taschenbergi* var. *aterrimus* Wheeler. Members of this subgenus are known to occur from Canada to the Gulf of Mexico and from the Atlantic Ocean to approximately as far west as the 104th degree of longitude. Colonies vary from small to moderately large according to forms. Nests are commonly constructed in the soil at the base of plants, but may also be found in hollow stems, in curled leaves, or in carton attached to stalks of plants. Although the ants are very fond of honeydew they also feed on the flesh of small arthropods.

Wheeler, 1905, characterizes the odor of the fluid emitted by their anal or repugnatory glands as "a peculiar smoky or pungent odor, fainter in *mariae* and stronger and of a somewhat different character in *gagates (aterrimus)*."

LIOMETOPUM Mayr

Pl. 16, Fig. 61

Liometopum Mayr, 1861, Die Europäischen Formiciden, p. 38.
Genotype, *Formica microcephala* Panzer (monobasic).
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:961.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:330.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:321-333, illus.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:521.
*Eckert and Mallis, 1937, Univ. Calif. Agr. Expt. Sta. Circ. 342: 17, illus.
Mallis, 1941, So. Calif. Acad. Sci. Bul. **40**:75.
Cole, 1942, Amer. Midl. Nat. **28**:371.

Length 2.5-6 mm. Integument soft, flexible. Head, including mandibles of largest workers, subcordate. Antenna 12-segmented, fossa touching posterior border of clypeus. Ocelli not always easily seen. Eye placed well toward the median line of the head. Anterolateral angles of the clypeus somewhat protuberant. Frontal carinae short, rather well separated. Maxillary palpus with 6 segments, labial palpus with 4 segments. Mandibles with well-developed teeth or denticulae, which are often numerous. Thorax without a conspicuous impression before the epinotum, in profile the dorsal surface of the thorax forming an almost uninterrupted arch. Petiole with a suberect or erect scale, the superoir border of which is rather pointed and often thin. Cloacal orifice inferior. Erect hairs on body more numerous in some forms than others. Gaster clothed with a very dense pubescence which imparts a characteristic grayish or ashy tinge. Three forms, †*apiculatum* Mayr, †*apiculatum luctuosum* Wheeler, †*occidentale* Emery. One or more of these have been found in Texas, New Mexico, Arizona, Colorado, California, Wyoming and Oregon. *L. occidentale* appears to be the most common form in California. *L. apiculatum luctuosum* is usually found at high altitudes where it is associated with conifers, especially pines. *L. occidentale* is more adaptable, ranging from the lowlands to elevations as high as 6,000 feet. The ants of this genus nest in the soil and also in crevices or beneath the bark of trees. The colonies of *occidentale* are sometimes rather large. Workers of this ant often invade houses. Workers of *Liometopum* are both predaceous and honeydew-loving. They are commonly seen traveling in well-defined trails. They are very pugnacious, inflicting wounds with their mandibles and squirting into the wounds a fluid from their anal glands.

IRIDOMYRMEX Mayr

Pl. 16, Fig. 62

Iridomyrmex Mayr, 1862, Zool.-Bot. Gesell. Wien, Verh. **12**:702.
Genotype, *Formica detecta* F. Smith (by designation of Bingham, 1903).
Roger, 1863, Berlin. Ent. Ztschr. **7**:165.
Mayr, 1868, Soc. dei Nat. di Modena Ann. **3**:164.
Emery, 1890, Soc. Ent. Ital. Bol. **22**:56.
André, 1893, Rev. de Ent., p. 148.
Newell, 1908, Jour. Econ. Ent. **1**:28.
Woodworth, 1910, Univ. Calif. Agr. Expt. Sta. Bul. 207: 65, 66, 72, illus.

Newell and Barber, 1913, U. S. Dept. Agr. Bur. Ent. Bul. 122, illus.
*Smith, 1929, Jour. Econ. Ent. **22**:241.
Cole, 1936, Ent. News **47**:121.
Metcalf and Flint, 1939, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., p. 769.
*Cole, 1940, Amer. Midl. Nat. **24**:64.

Length 1.5-2.6 mm. Integument thin, flexible, finely sculptured. Antenna 12-segmented; fossa touching posterior border of clypeus. No ocelli. Eye placed well toward the median line of the head. Mandibular dentition variable, ranging from denticulae to teeth. Maxillary palpus 6-segmented, neither unusually long nor with an extremely long third segment. Mesoepinotal region with a distinct to conspicuous impression or constriction. Petiolar scale distinct, inclined, not terminating above in a long acute angle or point as in *Limetopum*. Clocal orifice inferior. Body almost devoid of hairs or only sparsely pilose. Pubescence fine, closely appressed, and rather dense in some forms. The members of this genus are most apt to be confused with those of *Forelius* since the forms of neither group have as distinct structural characters as those of *Dolichoderus (Hypoclinea), Dorymyrmex (Conomyrma), Liometopum* or *Tapinoma*. Five forms, †*humilis* Mayr, †*iniquus* var. *nigellus* Emery, †*pruinosus* (Roger), †*pruinosus* var. *analis* (André), †*pruinosus* var. *testaceus* Cole. *I. humilis,* the introduced Argentine ant, is almost entirely restricted to the Southern States and California. *I. iniquus* var. *nigellus,* another introduced form, is established in a number of greenhouses, especially in the northeastern section of the country. The native *pruinosus* and its variety *analis* are confined largely to the Southern States. The Argentine ant is one of the worst house-infesting forms of all these. *I. pruinosus* var. *analis* also infests houses. Nests of the ants of this genus may be found in rotten wood, in freely exposed soil, or in the soil beneath objects such as stones and logs. The Argentine ant is noted for the many associated queens found in a colony. The various forms of *Iridomyrmex* are well-known for their honeydew-seeking habits as well as for being carnivorous. The workers of *pruinosus* and *analis* are capable of emitting a disagreeable, rotten-coconut or "tapinoma" odor. The crushed worker of the Argentine ant has a somewhat musty or greasy odor. For a full account of the Argentine ant the reader is referred to Newell and Barber, 1913.

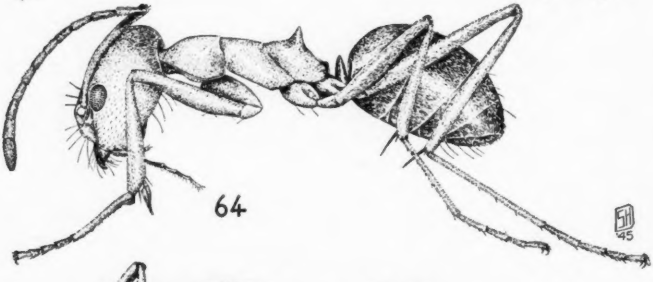
FORELIUS Emery

Pl. 17, Fig. 63

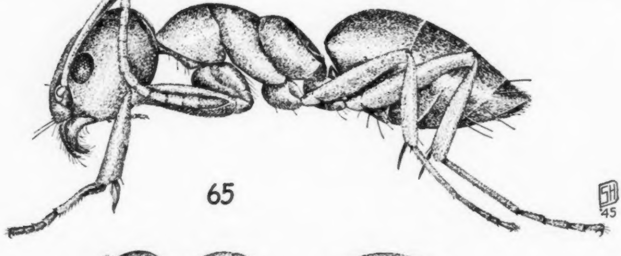
Forelius Emery, 1888, Ztschr. f. Wiss. Zool. **46**:389.
Genotype, *Iridomyrmex maccooki* Forel (monobasic).
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:168.
Forel, 1878, Soc. Vaud. des Sci. Nat. Bul. **15**:382.
Forel, 1886, Soc. Ent. de Belg. Bul. (C. R.) **30**:XXXIX.
Emery, 1888, Ztschr. f. Wiss. Zool. **46**:389.

Integument thin, flexible, finely sculptured. Petiole small, low, inclined. Antenna 12-segmented; fossa touching posterior border of clypeus. Maxillary palpus 6-segmented, labial palpus 4-segmented. Ocelli absent. Eye placed well toward the median line of the head. Thorax impressed at the mesoepinotal region. Proventriculus with a convex, 4-lobed calyx. Gaster produced anteriorly over the petiole. Cloacal orifice inferior.

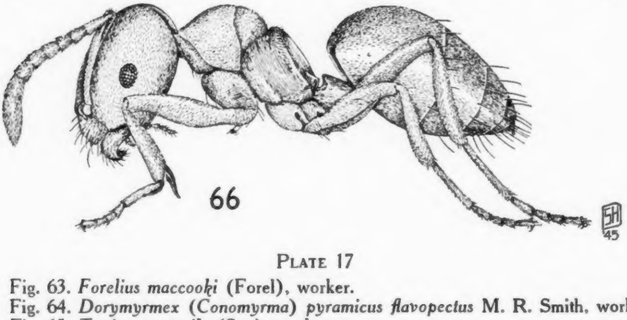
63



64



65



66

PLATE 17

Fig. 63. *Forelius maccooki* (Forel), worker.
Fig. 64. *Dorymyrmex (Conomyrma) pyramicus flavopectus* M. R. Smith, worker.
Fig. 65. *Tapinoma sessile* (Say), worker.
Fig. 66. *Brachymyrmex (Brachymyrmex)* sp., worker.

Forel, 1886, characterizes the single form, †*maccooki* (Forel), as follows:

"Length 2-3 mm. Head rectangular, feebly emarginate behind, with the sides almost subparallel. Mesoepinotal impression feeble, indistinct. Pronotum and mesonotum together forming an arch. Epinotum feebly arched, not elevated. Petiolar scale narrow, small. Body shining, very finely reticulated, feebly pubescent, with rather short, sparse, erect hairs. Tibiae and scapes bearing erect hairs. Yellowish red, extremity of funiculus and teeth of mandibles brownish."

As previously mentioned, the worker of *Forelius* is almost indistinguishable externally from that of an *Iridomyrmex,* which perhaps explains why Forel first described *maccooki* as a member of that genus. Emery, 1888, erected the genus *Forelius* and established *maccooki* as the genotype. The genus was based principally on an internal character, the form of the proventriculus, which is noticeably different from that of an *Iridomyrmex.*

Although originally described from Texas, *maccooki* has also been reported from several southwestern and western states. Its nests in the soil are freely exposed or placed under such objects as stones. The earth is often thrown from the nest in the form of a small crater. The workers may forage singly or in a file. Their food is probably honeydew supplemented by the flesh of small arthropods. Workers have anal or repugnatorial glands capable of emitting a fluid with "tapinoma" odor. Buckley's *Formica foetida* is thought to be the same as *Forelius maccooki.*

DORYMYRMEX, subgenus CONOMYRMA Forel

Pl. 17, Fig. 64

Dorymyrmex, subg. *Conomyrma* Forel, 1913, Rev. Zool. Afric. **2**:350.
Subgenotype, *Prenolepis pyramica* Roger (by designation of Santschi, 1922).
Roger, 1863, Berlin. Ent. Ztschr. **7**:160.
McCook, 1879, *in* Comstock's Report on Cotton Insects, p. 186.
Pergande, 1895, Calif. Acad. Sci. Proc. (2) **5**:871.
Wheeler, 1906, Amer. Mus. Nat. Hist. Bul. **22**:342.
Cole, 1936, Ent. News **47**:120.
*Cole, 1940, Amer. Midl. Nat. **24**:61.
Smith, 1944, Fla. Ent. **27**:15.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:291.

Monomorphic. Length approximately 2-3 mm. Integument thin, flexible. Eye placed well toward the median line of the head. Ocelli absent. Antenna 12-segmented; fossa touching posterior border of clypeus. Ventral surface of head usually with a psammophore which is often weakly developed or vestigial. Clypeus not carinate. Mandible with a strongly curved external border, apex with a long tooth and several smaller teeth. Maxillary palpus long, 6-segmented; the 3d segment very long, approximately as long as the succeeding segments combined. Epinotum with a prominent conical or tuberculate elevation. Thorax usually without any erect hairs. Petiole well-developed, scale-like. Gaster with a basal impression. Cloacal orifice inferior. Six forms, †*pyramicus* (Roger), †*pyramicus* var. *bicolor* Wheeler, †*pyramicus flavopectus* M. R. Smith, †*pyramicus* var. *flavus* McCook, †*pyramicus* var. *niger* Pergande,

†*pyramicus* var. *smithi* Cole. The ants of this subgenus are distributed mainly over the region south of the 42d degree of latitude and are especially common in the Southern States. Nests are constructed in the soil in more or less exposed places. The nest can usually be recognized by the crater-like mass of soil surrounding each nest entrance. The colonies are small. Although the workers are fond of honeydew they are also predaceous. They are very active and often aggressive. The workers possess anal or repugnatorial glands which emit a fluid with the characteristic, disagreeable "tapinoma" odor.

TAPINOMA Förster

Pl. 17, Fig. 65

Tapinoma Förster, 1850, Hymenopterologische Studien **1**:43.
Genotype, (*Tapinoma collina* Förster) = *Formica erratica* Latreille (monobasic).
Fabricius, 1793, Ent. Syst. **2**:353.
Say, 1835, Boston Jour. Nat. Hist. **1**:287.
*Bingham, 1903, Fauna British India, Hymen. **2**:304.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:109.
*Smith, 1928, Ent. Soc. Amer. Ann. **21**:307, illus.
Essig, 1926, Insects of Western North America, Macmillan Co., p. 863, illus.
Wheeler, 1932, N. Y. Ent. Soc. Jour. **40**:13.
*Eckert and Mallis, 1937, Univ. Calif. Agr. Expt. Sta. Circ. 342: 17, illus.
Metcalf and Flint, 1939, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., p. 770.
Wesson and Wesson, 1940, Amer. Midl. Nat. **24**:100.

Length 1.25-3.2 mm. Integument thin, flexible, feebly sculptured. Antenna 12-segmented; fossa touching posterior border of clypeus. Anterior border of clypeus with a weak to a very distinct emargination. Eye placed well toward the median line of the head. No ocelli. Mandible with numerous small teeth or denticulae. Maxillary palpus 6-segmented, labial palpus 4-segmented. Mesoepinotal constriction distinct. The flattened declivous surface of the epinotum distinctly longer than the base. Petiolar node vestigial, inclined; when viewed from above, more or less hidden by the base of the gaster. Base of first gastric segment with a conspicuous impression. Cloacal orifice inferior. Erect or suberect hairs sparse on body. Pubescence short, closely appressed, often rather dense on body but not obscuring the surface in some lights. Three forms, †*litorale* Wheeler and the introduced †*melanocephalum* (Fabricius) of Florida, and †*sessile* (Say) which apparently occurs in every state of the Union. *T. sessile* is one of our most common and highly adaptable forms, nesting at elevations ranging from sea level to over 10,000 feet, and occurirng on sandy coasts, bogs, prairies, hills or mountains. Their nests may be found in the soil, beneath debris, under bark of logs and stumps, in cavities of plants, in insect galls, or even in bird nests. Although *sessile* is well-known for its honeydew-seeking habits, the workers derive a great deal of food from the flesh of small arthropods and the juices of decaying fruits and vegetables. Workers are capable of emitting from their anal glands a fluid with the disagreeable "tapinoma" or rotten-coconutlike odor. For a detailed biological account of *sessile* see Smith, 1928. Both *sessile* and *melanocephalum* are common house-infesting forms.

Subfamily Formicinae Lepeletier

Formicites Lepeletier, 1836, Hist. Nat. Ins. Hymen. **1**:197.
Formicinae Wheeler, 1920, Psyche **27**:51.

Cloacal orifice terminal, circular, surrounded by a fringe of hairs. No sting. Pedicel consisting of a single segment, the petiole. No constriction between the first and second gastric segments. Eye well-developed, seldom rudimentary. Ocelli present or absent. Antenna 12-segmented except in the genus *Brachymyrmex* in which it is 9-segmented; funiculus without a club. Antennal fossa touching or not touching the posterior border of the clypeus. Frontal area usually distinct. Sutures usually present on the dorsum of the thorax. Petiole generally scalelike; erect or anteriorly inclined. Body usually weakly sculptured. Character and abundance of pilosity and pubescence highly variable. Monomorphic, dimorphic, or polymorphic. Pupae generally enclosed in cocoons, but sometimes naked. Nests usually constructed in the soil, logs, stumps, crevices in trees and plants, insect galls, or even in houses. Colonies extremely variable with respect to number of individuals, some containing only a few hundred, others many thousands. Food somewhat diverse, including honeydew, sap, juices of fruits and flesh of arthropods. Some Formicinae even foster mealybugs and plant lice. This subfamily, which contains 272 forms, is our second largest subfamily of ants. Although representatives occur in every state, more forms are found in the northern section of the United States than elsewhere. Many of these infest houses. The black carpenter ant, *Camponotus herculeanus pennsylvanicus* (Degeer), not only infests houses but sometimes injures woodwork by constructing its nests therein. This ant is also known to injure telephone poles or even certain species of live trees.

1. Antenna with 9 segments. (Small species, 1.5-2 mm. in length. Epinotum with a very short base and an unusually long declivity. Petiolar node inclined, usually concealed from above by the base of the gaster.) Pl. 17, fig. 66 .... *Brachymyrmex*, subgenus *Brachymyrmex* Mayr, p. 601

   Antenna with more than 9 segments 2

2. (1) Mandible narrow, falcate, with pointed apex, internal border minutely serrated. Pl. 22, fig. 85a. (Scape somewhat abruptly enlarged toward the apex. Clypeus short, the anterior border truncate or broadly but not deeply excised. Maxillary palpus 4-segmented, labial palpus 2-segmented. Petiole erect, usually thick anteroposteriorly. Habitus somewhat like that of a *Formica*.) Pl. 22, fig. 85 .... *Polyergus* Latreille, p. 625

   Mandible not as described above 3

3. (2) Antenna inserted at or very close to the posterior border of the clypeus 4

   Antenna inserted a considerable distance from the posterior border of the clypeus. (Clypeal border and antennal fossa never touching each other. Polymorphism usually pronounced. Large species, 3-15 mm. in length.) .... *Camponotus* Mayr

   a. Head, from above, subcylindrical or with the sides slightly divergent anteriorly. The anterior surface truncate, more or less circular and with marginate border. Pl. 19, fig. 71 .... *Camponotus*, subgenus *Colobopsis* Mayr, p. 606

      Not as described above. (The head may be truncate or not, but if truncate, it is not of the shape described for *Colobopsis*.) .... b

   b. (a) Head truncate c

      Head not truncate .... d

c. (b) Truncate area with an elongate, irregular, deep, pitlike impression beneath each eye and exterior to the clypeus and frontal carina. Arizona. (Only one form, *ulcerosus* Wheeler.) Pl. 19, fig. 73 .... *Camponotus*, subgenus *Manniella* Wheeler, p. 607

Truncate area without pitlike impression as described above. Texas and California. Pl. 19, fig. 72 ....*Camponotus*, subgenus *Myrmaphaenus* Emery, p. 607

d. (b) Rather small, stout forms, with short legs. Anterior border of clypeus without a distinct but narrow notch or impression in the middle. Thorax arcuate in profile, flattened and submarginate anteriorly. Head and thorax subopaque or opaque, densely punctate. Hairs on body, and especially the gaster, abundant, white, suberect or erect. (Florida, Texas and Arizona.) Pl. 19, fig. 74 ....*Camponotus*, subgenus *Myrmobrachys* Forel, p. 609

Unlike alternative in one or more characters .... e

e. (d) Legs and most of body with abundant, long, yellowish, suberect to erect hairs, the hairs on the legs not arranged as a row of short, graduated bristles on the flexor surface of each middle and hind tibia. Head, thorax, petiole and legs yellowish or reddish, gaster black. Head subopaque, remainder of body shining. Scape stout, flattened basally but not lobed. Clypeus carinate. (Texas, Florida, Georgia, South Carolina, North Carolina.) Pl. 18, fig. 69 ....*Camponotus*, subgenus *Myrmothrix* Forel, p. 605

Not agreeing with the above .... f

f. (e) Anterior border of clypeus with a very distinct, narrow, median (notchlike) emargination or impression. Clypeus either without a carina or else with a very feeble one. Scape not lobed at the base. Each middle and hind tibia usually without a row of short, graduated bristles on the flexor surface. Hairs on legs not unusually long or abundant. Cheeks and clypeus of some species with elongated, piligerous foveolae. (One of the largest and most common subgenera, with one or more forms present in every state.) Pl. 18, fig. 70 ....*Camponotus*, subgenus *Myrmentoma* Forel, p. 605

Differing in one or more characters .... g

g. (f) Clypeus with a pronounced lobe and a rather distinct carina. Scape not lobed, weakly or not at all flattened basally. Each middle and hind tibia without a row of short, graduated bristles on their flexor surface. Each middle and hind tibia in some forms with a longitudinal sulcus. (Florida, Texas, Arizona.) Pl. 18, fig. 68 ......*Camponotus*, subgenus *Tanaemyrmex* Ashmead, p. 603

Not entirely as described above. (The largest and most common subgenus with one or more forms present in every state. The subgenus includes some of our largest ants.) Pl. 18, fig. 67 ....*Campanotus*, subgenus *Campanotus* Mayr, p. 602

4. (3) Most or all of eye at the rear of the middle of the side of the head 5

Most or all of eye anterior to the middle of the side of the head ....*Paratrechina* Motschoulsky, p. 609

a. Antenna and legs unusually long, the scape extending more than one-half its length beyond the posterior border of the head. Body slender. Long, coarse, suberect or erect hairs normally absent on the scape. Integument with a peculiar metallic sheen or luster. Introduced. One form, *longicornis* (Latreille). Pl. 20, fig. 75 ....*Paratrechina*, subgenus *Paratrechina* Motschoulsky, p. 609

Unlike alternative in one or more characters. Tibiae and scapes, especially the former, usually with coarse, suberect to erect hairs. Mostly native forms. Pl. 20, fig. 76 ....*Paratrechina*, subgenus *Nylanderia* Emery, p. 611

5. (4) Psammophore present. Maxillary palpus unusually long with the 4th segment approximately as long as, or longer than the combined lengths of the 5th and 6th segments. (Habitus somewhat similar to that of *Formica*.) Texas, Oklahoma, New Mexico, Colorado, Utah, Arizona, Idaho, California and Kansas. Especially typical of the arid regions. Pl. 21, fig. 81 ....*Myrmecocystus* Wesmael, p. 616

Unlike alternative in one or more characters. Not typical of the arid regions, with one or more forms present in every state. 6

6. (5) Thorax small, slender, with a remarkably strong constriction in the mesonotum. Antennal scape extending almost one-half its length beyond the posterior corner of the head. Gaster, from above, with the base meeting each side in a distinct angle. Pl. 20, fig. 77 .... *Prenolepis* Mayr, p. 612

Differing in one or more characters 7

7. (6) Frontal area not clearly defined. Ocelli usually indistinct or absent. Monomorphic. Small forms, usually ranging in length from 2-4 mm. Pl. 21, fig. 79 .... *Lasius* Fabricius.

a. Maxillary palpus short, 3-segmented. (Ants capable of emitting a pleasant lemon-verbena odor.) Pl. 20, fig. 78 .... *Lasius*, subgenus *Acanthomyops* Mayr, p. 615

Maxillary palpus 6-segmented .... b

b. (a) Terminal segments of the maxillary palpus more or less equal in length. Not light-avoiding; active ants above the surface of the soil. Pl. 21, fig. 79 .... *Lasius*, subgenus *Lasius* Fabricius, p. 613

Terminal segments of the maxillary palpus more or less decreasing in length toward the apex. Many forms subterranean in habit and apparently light-avoiding. Pl. 21, fig. 80 .... *Lasius*, subgenus *Chthonolasius* Ruzsky, p. 613

Frontal area clearly defined. Ocelli distinct. Polymorphic. Larger forms; ranging from 2.5-9 mm. in length, the major workers usually 4.5-9 mm. Pl. 22, fig. 84 .... *Formica* Linnaeus

a. First funicular segment approximately as long as the combined lengths of the 2d and 3d funicular segments. Small forms (2.5-5 mm.), rather smooth and shining. Erect hairs present on gula and usually on the petiole. Pl. 22, fig. 83 .... *Formica*, subgenus *Proformica* Ruzsky, p. 617

Differing in one or more characters .... b

b. (a) Scape slender, weakly curved at the base, approximately one and one-fourth to one and one-third times the length of the head. Thorax slender. Pl. 22, fig. 82 .... *Formica*, subgenus *Neoformica* Wheeler, p. 619

Scape not as described above. Thorax usually stout. Pl. 22, fig. 84 .... *Formica*, subgenus *Formica* Linnaeus, p. 620

BRACHYMYRMEX, subgenus BRACHYMYRMEX Mayr

Pl. 17, Fig. 66

Brachymyrmex Mayr, 1868, Soc. dei Nat. di Modena Ann. **3**:163.
Subgenotype, *Brachymyrmex patagonicus* Mayr (monobasic).
Forel, 1893, Lond. Ent. Soc. Trans., p. 345.
Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:635.
Wheeler, 1903, Psyche **10**:102-103, illus.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:389.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:590.
*Santschi, 1923, Ann. Mus. Nac. Hist. Nat. Buenos Aires **31**:663, 664, 666, illus.
Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:865, 866.
Cole, 1940, Amer. Midl. Nat. **24**:65.

Monomorphic. Length 1.5-2 mm. Integument soft, flexible. Posterior border of head often emarginate. Antenna 9-segmented, funiculus without a distinct club, antennal fossa touching the posterior border of the clypeus. Maxillary palpus 6-segmented, labial palpus 4-segmented. Eye well-developed. Clypeus convex. Frontal carinae short, not spaced far apart. Frontal area distinct. Thorax short, stout, with an aspect somewhat like that of a *Lasius*.

Mesonotum short, much broader than long. Mesoepinotal impression distinct. Epinotum with an unusually short base and a very long, sloping declivity. Petiolar node inclined, usually concealed by the base of the gaster. Gaster with a basal impression. Pubescence fine or coarse, closely appressed or slightly raised. Hairs rather sparse, often absent on the thorax. Three forms, †*heeri* var. *obscurior* Forel of Florida, the common †*depilis* Emery of at least the eastern half of the United States, and †*nanellus* Wheeler of Texas. There are, no doubt, a number of undescribed forms. The ants form small colonies in the soil or in rotting wood. The workers which are mostly of subterranean habits derive much of their food from honeydew obtained from plant lice and mealybugs on the roots of plants. This subgenus contains some of our smallest ants. All are native except perhaps *heeri* var. *obscurior* which may have been introduced into Florida.

CAMPONOTUS, subgenus CAMPONOTUS Mayr

Pl. 18, fig. 67

Camponotus Mayr, 1861, Die Europäischen Formiciden, p. 35.
Subgenotype, *Formica ligniperda* Latreille (by designation of Bingham, 1903).
Degeer, 1773, Mem. Hist. Insect. **3**:603, illus.
Fabricius, 1798, Ent. System. Suppl., p. 279.
Latreille, 1802, Hist. Nat. de Fourmis, p. 118, illus.
Fitch, 1855, N. Y. State Agr. Soc. Trans. **14**:766.
F. Smith, 1858, Catalogue of Hymenopterous Insects in the Collection of the British Museum, pt. 6, p. 55.
Mayr, 1862, Zool.-Bot. Gesell. Wien, Verh. **12**: Abt. 2, 661.
Roger, 1863, Berlin. Ent. Ztschr. **7**:140.
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:167.
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:940.
Forel, 1879, Soc. Vaud. des Sci. Nat. Bul. **16**:69.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:671-675, illus.
Forel, 1902, Lond. Ent. Soc. Trans., p. 699.
Wheeler, 1906, Psyche **13**:41.
Pricer, 1908, Biol. Bul. **14**:177, illus.
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:301-310, 317-320, 321-325, 327-341, 354.
Forel, 1914, Deut. Ent. Ztschr., pp. 619, 620.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:420.
*Wheeler, 1916, Conn. State Geol. and Nat. Surv. Bul. **22**:600.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:556-557, 558-562.
Wheeler, 1932, N. Y. Ent. Soc. Jour. **40**:15.
Santschi, 1936, Rev. de Ent. **6**:204.
*Cole, 1940, Amer. Midl. Nat. **24**:84.
*Cole, 1942, Amer. Midl. Nat. **28**:387.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:293.

Large to very large forms (5-15 mm.). Head of worker major robust. Clypeus either without a carina or else with a weakly developed carina, no anterior lobe, or else anterior lobe weakly projecting, rounded, or more or less rectangular, very seldom with an emargination. Mandibles 4-6 toothed. Thoracic dorsum convex, usually continuous in profile. Dorsum of prothorax rounded, sometimes depressed. Middle and hind tibiae in many forms each with a row of graduated bristles on their flexor surface. Antennal scape often flattened at the base or even lobed. In *acutirostris*, *ocreatus* and their forms the middle of the anterior border of the clypeus has a prominent

angular point. One of the largest subgenera of *Camponotus,* with 29 forms, †*acutirostris* Wheeler, *acutirostris* var. *clarigaster* Wheeler, †*castaneus* (Latreille), †*castaneus americanus* Mayr, *castaneus rufinasis* Santschi, †*herculeanus ligniperdus noveboracensis* (Fitch), *herculeanus ligniperdus rubens* Wheeler, †*herculeanus* var. *modoc* Wheeler, †*herculeanus pennsylvanicus* (Degeer), †*herculeanus pennsylvanicus ferrugineus* (Fabricius), *herculeanus pennsylvanicus mohican* Wheeler, †*herculeanus* var. *whymperi* Forel, †*laevigatus* (F. Smith), †*ocreatus* Emery, †*ocreatus primipilaris* Wheeler, †*sansabeanus* (Buckley), †*sansabeanus bulimosus* Wheeler, †*sansabeanus dumetorum* Wheeler, †*sansabeanus maccooki* Forel, †*sansabeanus vicinus* Mayr, *sansabeanus vicinus infernalis* Wheeler, †*sansabeanus vicinus luteangulus* Wheeler, *sansabeanus vicinus maritimus* Wheeler, †*sansabeanus vicinus nitidiventris* Emery, *sansabeanus vicinus plorabilis* Wheeler, †*sansabeanus vicinus semitestaceus* Emery, *sansabeanus* var. *torrefactus* Wheeler, †*socius* Roger, *socius* var. *osceola* Wheeler. One or more of these are present in every state. Most of the forms belong to *sansabeanus* or *herculeanus,* there being 14 variants of the former and 7 of the latter. Representatives of *herculeanus* occur in every state and those of *sansabeanus* from approximately the 93d degree of longitude westward. One of the best known forms of *herculeanus* is the black carpenter ant, *herculeanus pennsylvanicus,* which infests homes, injures telephone poles and some types of timber, and even occasionally mines out wood in buildings. Some members of the subgenus nest entirely in wood whereas others prefer the soil. Colonies are usually moderately large to large. The food is mainly the flesh of small arthropods, the sap of plants and fruits, and honeydew. For a detailed account of the biology of the black carpenter ant, see Pricer, 1908.

CAMPONOTUS, subgenus TANAEMYRMEX Ashmead

Pl. 18, Fig. 68

Tanaemyrmex Ashmead, 1905, Canad. Ent. **37**:384.
Subgenotype, *Formica longipes* Gerstäker (by original designation).
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:670.
Emery, 1895, Zool. Jahrb., Abt. f. System. **8**:336.
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:164.
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:310-317.
Wheeler, 1932, N. Y. Ent. Soc. Jour. **40**:13.

Length 6-14 mm. Base of antennal scape feebly or not at all flattened. Cheeks and clypeus with elongate punctures or foveolae. Middle and hind tibiae each without long, suberect hairs, also without a row of graduated bristles on the flexor surface. Clypeus with a pronounced lobe and a rather distinct carina. Head wider behind than anteriorly. Antenna inserted in front of the midlength of the frontal carina. Middle and hind tibia in some forms, each with a longitudinal sulcus. Five forms, †*fumidus* var. *festinatus* (Buckley), *fumidus* var. *spurcus* Wheeler, *incensus* Wheeler, †*tortuganus* Emery, and †*vafer* Wheeler. *C. (T.) incensus* and *tortuganus* have been collected in Florida, *fumidus* varieties *festinatus* and *spurcus* are known from Texas and Arizona, and *vafer* occurs in Arizona. Variants of *fumidus* may also be expected to occur in California. So far as known the ants nest in the soil beneath logs, stones or other objects.

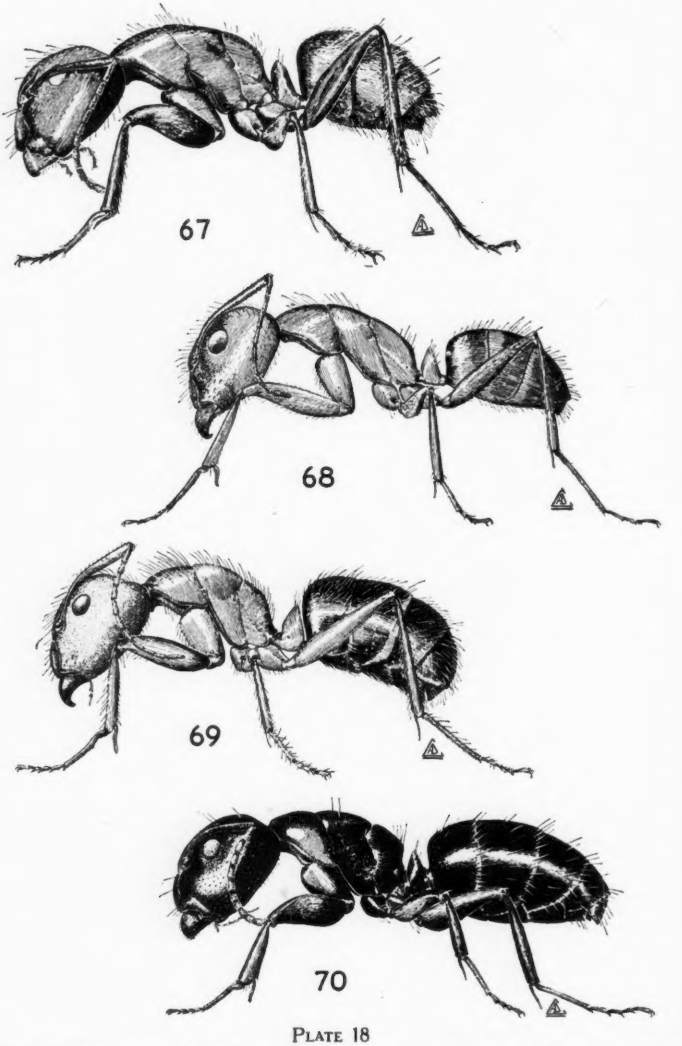


PLATE 18

Fig. 67. *Camponotus* (*Camponotus*) *herculeanus pennsylvanicus* (Degeer), major worker.
Fig. 68. *Camponotus* (*Tanaemyrmex*) *fumidus* Roger var., major worker.
Fig. 69. *Camponotus* (*Myrmothrix*) *abdominalis floridanus* (Buckley), major worker.
Fig. 70. *Camponotus* (*Myrmentoma*) *caryae nearcticus* Emery, major worker.

CAMPONOTUS, subgenus MYRMOTHRIX Forel
Pl. 18, Fig. 69

Camponotus, subg. *Myrmothrix* Forel, 1912, Soc. Ent. de Belg. Mem. **20**:91.
Subgenotype, *Formica abdominalis* Fabricius (by designation of Wheeler, 1913).
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:161.
Mayr, 1866, Zool.-Bot. Gesell. Wien, Verh. **36**:423.
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:325-326.

Length 5.5-10 mm. Body and legs clothed with long, abundant, suberect to erect, yellowish hairs; those on the tibiae not arranged as a row of graduated, short bristles. Antennal scape stout, flattened, not lobed at the base, and bearing short, suberect to erect hairs. Clypeus carinate, anterior border extended as a broad truncate lobe which bears a slight median emargination. Head, thorax, petiole and legs yellowish or reddish, gaster black. Head infuscated dorsally in *transvectus*. Head subopaque, remainder of body shining. Cheeks often with peligerous foveolae. This subgenus contains only two forms, †*abdominalis floridanus* (Buckley), and †*abdominalis transvectus* Wheeler. The former has been recorded from Florida, Georgia and South Carolina, the latter from southern Texas. *C. floridanus* seems to be very common in Florida where it nests in rather large colonies in logs, stumps and dead branches of trees. The workers are very aggressive. They are known to infest houses and beehives. The feeding habits of the ants of this subgenus are no doubt similar to those of the other groups of *Camponotus*.

CAMPONOTUS, subgenus MYRMENTOMA Forel
Pl. 18, Fig. 70

Camponotus, subg. *Myrmentoma* Forel, 1912, Soc. Ent. de Belg. Mem. **20**:92.
Subgenotype, *Formica lateralis* Olivier (by designation of Wheeler, 1913).
Fitch, 1855, N. Y. State Agr. Soc. Trans. **14**:855.
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:166.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:675, illus.
Pergande, 1894, Calif. Acad. Sci. Proc. (2) **4**:161.
Wheeler, 1903, Psyche **10**:108, illus.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:271.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:88.
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:342-346.
*Wheeler, 1910, N. Y. Ent. Soc. Jour. **18**:216.
Wheeler, 1911, N. Y. Ent. Soc. Jour. **19**:96.
Wheeler, 1917, Psyche **24**:26.
Smith, 1923, Ent. News **34**:306.
Smith, 1940, Ent. Soc. Wash. Proc. **42**:137, illus.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:293.

Length 3.5-12 mm., the major workers of most forms averaging approximately 6-8 mm. Clypeus without a carina or else with a very feeble one; anterior border with a narrow but distinct, median notchlike emargination or impression. Mandible with 5 or 6 teeth. Thorax short, robust, not or very weakly marginate; in profile, with a continuous arch, which is occasionally interrupted by an impression in the mesoepinotal region. Middle and hind tibiae usually without bristles on their flexor surfaces. Cheeks and clypeus in some species with elongate, piligerous foveolae. Most of body usually shining. One of the largest subgenera with one or more forms, no doubt,

occurring in every state. Nineteen forms, †*anthrax* Wheeler, †*caryae* (Fitch), †*caryae* var. *decipiens* Emery, †*caryae discolor* (Buckley), †*caryae discolor clarithorax* Emery, †*caryae* var. *essigi* M. R. Smith, †*caryae* var. *minutus* Emery, †*caryae nearcticus* Emery, *caryae* var. *pardus* Wheeler, †*caryae rasilis* Wheeler, †*caryae rasilis pavidus* Wheeler, †*caryae subbarbatus* Emery, †*caryae subbarbatus paucipilis* Emery, †*caryae* var. *tanquaryi* Wheeler, †*hyatti* Emery, *hyatti* var. *bakeri* Wheeler, †*sayi* Emery, †*schaefferi* Wheeler, †*texanus* Wheeler. The subgenus is badly in need of revision and the names used here will probably be considerably altered when the group is thoroughly reworked. The names are substantially those given by Wheeler in Psyche, 1917. The present author indicated in 1940 (see citation above) that *caryae* and *nearcticus* are not synonymous. The confusion between these two forms has led to a number of erroneous records in literature. The ants of the subgenus *Myrmentoma* form small colonies of only a few hundred individuals in crevices in trees and plants, insect galls, dead wood or even in the wooden structure of houses. Workers are exceedingly fond of honeydew. Certain species such as *rasilis* and *nearcticus*, infest houses where they show an especial fondness for sweets.

CAMPONOTUS, subgenus COLOBOPSIS Mayr

Pl. 19, Fig. 71

Colobopsis Mayr, 1861, Die Europäischen Formiciden, p. 38.
Subgenotype, *Formica truncata* Spinola (by designation of Bingham, 1903).
Roger, 1863, Berlin. Ent. Ztschr. **7**:160.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:139, illus.
*Wheeler ,1910, N. Y. Acad. Sci. Ann. **20**:352-353.
Smith, 1923, Psyche **30**:82.
Smith, 1930, Ent. Soc. Amer. Ann. **23**:567.
Wheeler, 1934, Harvard Univ. Mus. Compar. Zool. Bul. **77**:214.
Emery, 1920, Soc. Ent. Ital. Bol. **52**:34.

Length 3-6 mm. Head subcylindrical, with the sides subparallel or slightly divergent anteriorly, and the anterior portion truncate. Truncated area almost circular in outline, often sharply margined, especially on the sides; the truncated area includes the mandibles, much or nearly all of the clypeus, and the anterior medial portion of the cheeks; the truncate area often concave. Frontal carinae far apart, short, straight or weakly sigmoid. Antennal insertion placed at approximately the midlength or to the rear of the midlength of the frontal carina. Eye situated well to the rear of the side of the head. Anterior half of head coarsely reticulate rugose, subopaque. Petiole low, usually thick anteroposteriorly. Hairs on the anterior part of head usually short, erect, often obtuse or apically enlarged. Eight forms, *cerberulus* Emery, †*etiolatus* Wheeler, †*impressus* Roger, †*mississippiensis* M. R. Smith, †*obliquus* M. R. Smith, †*pylartes* Wheeler, †*pylartes fraxinicola* M. R. Smith, *pylartes* var. *hunteri* Wheeler. The ants of this subgenus are apparently confined to the southern half of the United States but may range slightly farther north in the region of the Mississippi Valley. Specimens have been received from as far north as Urbana, Ill. *C. impressus* appears to be one of the most abundant forms in Florida, while *mississippiensis* and *pylartes*, or its variants, occur commonly in the Gulf Coast region.

The ants nest in trees and shrubs, especially in the branches and twigs, in insect galls, or even in hollow nuts. Colonies are small. Workers are commonly observed foraging on trees and plants in search of honeydew which much comprise a large portion of their food.

CAMPONOTUS, subgenus MYRMAPHAENUS Emery
Pl. 19, Fig. 72

Camponotus, subg. *Myrmaphaenus* Emery, 1920, Rev. de Zool. et de Bot. Africaines **8**:237.
Subgenotype, *Camponotus leydigi* Forel (by original designation).
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:349-351.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:420.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:562.

Length 4-8 mm. Head longer than broad with slightly convex or subparallel sides and emarginate posterior border; convex above, obliquely truncate anteriorly. Truncate area neither subcircular nor marginate as in *Colobopsis*. Clypeus flattened. Antennal scape slender, not or only slightly flattened at base. At least clypeus and cheeks opaque, punctate foveolate or punctate rugose. Two species, *bruesi* Wheeler of Texas and *yogi* Wheeler of California. The former was collected from the trunk of an acacia, and the latter from the twig of a manzanita. So far as the author is aware, both species are known only from the type specimens. Wheeler states that *yogi* closely approaches the species of *Colobopsis* but differs in lacking the circular or distinctly marginate, truncate area, in the soldier.

CAMPONOTUS, subgenus MANNIELLA Wheeler
Pl. 19, Fig. 73

Camponotus, subg. *Manniella* Wheeler, 1921, Psyche **28**:19.
Subgenotype, *Camponotus sphaericus* Roger (by original designation).
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:351.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:562.
Emery, 1925, *in* Wytsman, Genera Insectorum, fasc. **183**:160, illus.

Major worker (soldier) 6.5 mm. Habitus somewhat similar to that of a *Colobopsis*. Head subrectangular, a little longer than broad, as broad in front as behind, with a nearly straight posterior border and feebly concave, subparallel sides. Posterior corners somewhat angular, anterior corners extended as rounded lobes beyond anterior border of clypeus and closed mandibles. In profile, the head is high and convex behind, flattened beneath, and obliquely truncate in front. Truncate surface with an elongate, irregular, rather deep impression on each side below the eye and exterior to the clypeus and frontal carina. Clypeus trapezoidal, flat, ecarinate. Frontal carinae far apart, lyrate in front, parallel behind and forming boundaries of rather deep scrobes for the reception of the base of each antennal scape. Head opaque, occiput and posterior angles shining; truncate anterior portion including mandibles, clypeus, the portions of the cheeks within the ridges and the anterior portion of the front, uneven and irregularly rugulose, remainder of head covered with dense uniform punctures, and scattered and rather deep foveolae. Foveolae slightly elongate on cheeks outside the ridges. Hairs glistening white, erect, abundant; longest on the gâster, petiole and thorax, shorter on

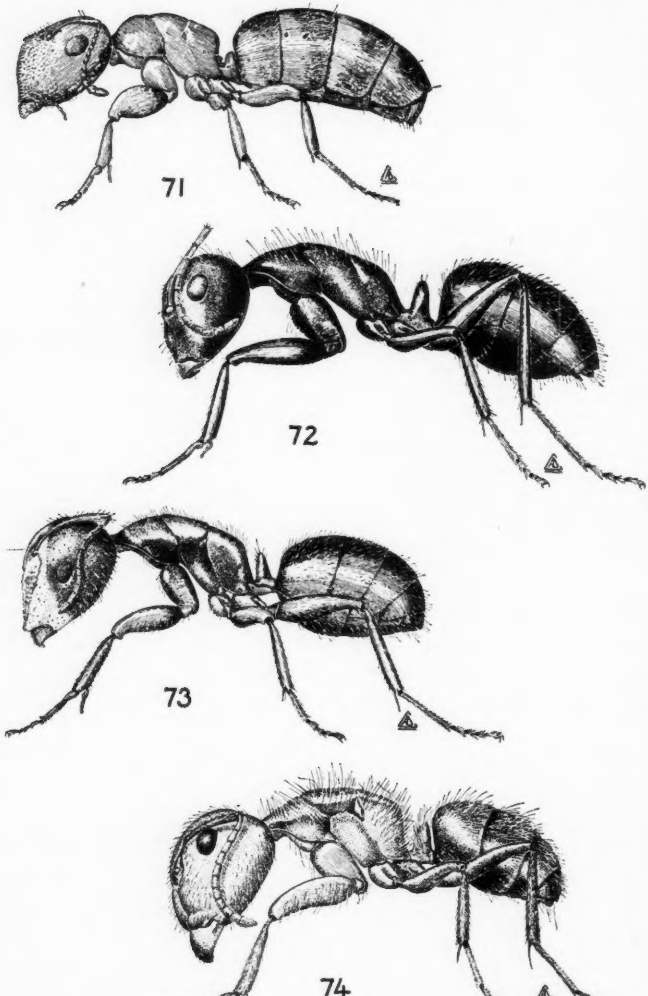


PLATE 19

Fig. 71. *Camponotus* (*Colobopsis*) *etiolatus* Wheeler, soldier.
Fig. 72. *Camponotus* (*Myrmaphaenus*) *bruesi* Wheeler, worker.
Fig. 73. *Camponotus* (*Manniella*) *ulcerosus* Wheeler, major worker.
Fig. 74. *Camponotus* (*Myrmobrachys*) *planatus* Roger, major worker.

the head, blunt on cheeks and sides of head. Antennae with short, delicate, erect hairs on the anterior surfaces and tips of the scapes. One species, †*ulcerosus* Wheeler, of Arizona. According to Wheeler several colonies were found in the Huachucha Mountains (at an altitude of 5,000-6,000 ft.) nesting in the ground beneath stones. Nothing more is known about the biology.

CAMPONOTUS, subgenus MYRMOBRACHYS Forel
Pl. 19, Fig. 74

Camponotus, subg. *Myrmobrachys* Forel, 1912, Soc. Ent. de Belg. Mem. **20**:91.
Genotype, *Formica senex* F. Smith (by designation of Wheeler, 1913).
Roger, 1863, Berlin. Ent. Ztschr. **7**:148.
*Wheeler, 1910, N. Y. Acad. Sci. Ann. **20**:346-349.

Rather small (3.5-7 mm.), stout species. Posterior border of head straight or weakly emarginate. Thorax short, arcuate in profile, weakly to moderately marginate anteriorly (in *planatus*, also flattened anteriorly). Legs short, middle and hind tibiae each without a row of graduated, short bristles on the flexor surface. Head and thorax opaque or subopaque, densely punctate. Hairs on body, especially the thorax and gaster, abundant, white, suberect to erect. Two forms, *mina zuni* Wheeler of Arizona and †*planatus* Roger of Florida and Texas. Both form small colonies. *C. planatus* nests in the hollow branches of trees, under bark and in logs. Although the workers attend plant lice, they also probably feed on the flesh of small arthropods.

PARATRECHINA, subgenus PARATRECHINA Motschoulsky
Pl. 20, Fig. 75

Paratrechina Motschoulsky, 1863, Bul. Soc. Nat. Moscou **36**(3):13.
Subgenotype, (*Paratrechina currens* Motschoulsky) = *Formica longicornis* Latreille (by designation of Wheeler, 1911).
Latreille, 1802, Hist. Nat. Fourmis, p. 113.
*Bingham, 1903, Fauna British India Hymen. **2**:326.
*Emery, 1910, Deut. Ent. Ztschr., p. 129, illus.
*Arnold, 1922, So. Afr. Mus. Ann. **14**:605, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., pp. 10, 154, 156, 221.
Marlatt, 1928, U. S. Dept. Agr. Farmers Bul. 740, p. 6.
*Phillips, 1934, Hawaii Univ. Expt. Sta. Pineapple Prod. Coop. Assn. Ltd. Bul. **15**:18.
*Smith, 1936, Puerto Rico Univ. Jour. Agr. **20**:869.

Length 2.2-3 mm. Slender. Integument thin, flexible, with a peculiar metallic sheen or lustre in some lights. Antenna 12-segmented; fossa close to but usually separated from the posterior border of the clypeus, scape unusually long, exceeding by more than one-half its length the posterior border of the head. Eye very prominent, convex, situated nearer the anterior than the posterior border of the head. Ocelli sometimes present but unusually small. Clypeus subcarinate. Frontal area indistinct or absent. Maxillary palpus long, 6-segmented. Mandible slender, usually with 5 teeth. Thorax lacking the prominent, subcylindrical mesonotal constriction which is present in *Prenolepis imparis* (Say). Legs remarkably long. Petiolar scale more or less inclined. Base of gaster with an impression; from above, base of gaster concave, distinctly angulate at each side. Body with long, coarse, pale yellowish, suberect

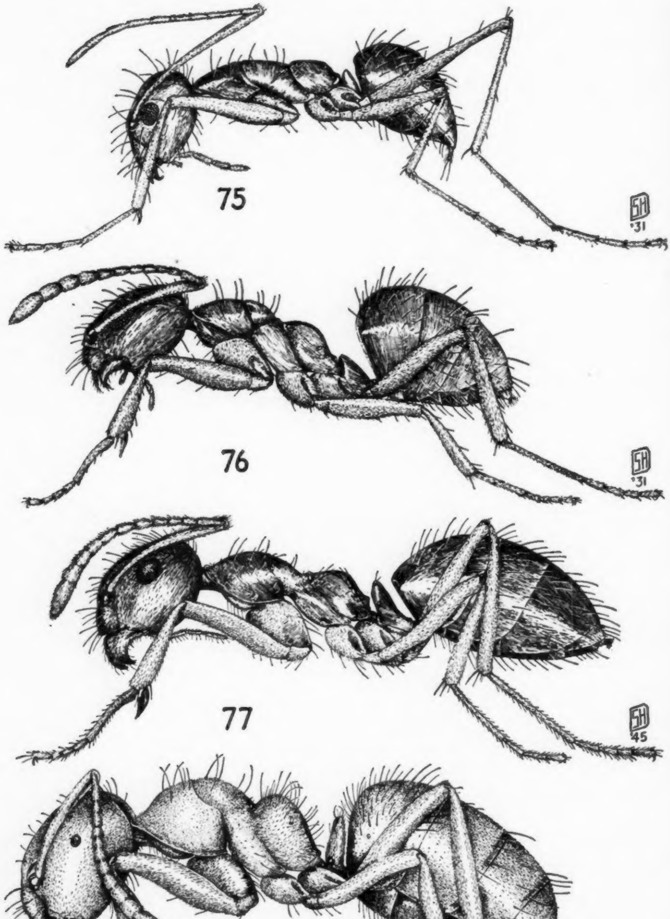


PLATE 20

Fig. 75. *Paratrechina* (*Paratrechina*) *longicornis* (Latreille), worker.
Fig. 76. *Paratrechina* (*Nylanderia*) *parvula* (Mayr), worker.
Fig. 77. *Prenolepis imparis* (Say), worker.
Fig. 78. *Lasius* (*Acanthomyops*) *interjectus* Mayr, worker.

to erect hairs. Hairs shorter and sparser, also more appressed on the legs, usually none present on the scape. A single, introduced species, †*longicornis* (Latreille), the "crazy ant," which is so called because of its habit of darting here and there in a senseless, uncontrolled manner. Its original home is thought to be India. The ant is now established in many towns and cities, especially of the states bordering the Gulf of Mexico and the Atlantic Ocean. It is commonly intercepted by plant quarantine inspectors. In the extreme South the ants may nest outdoors in the soil but in the colder regions they nest in hotels, apartment houses, greenhouses, and other buildings. The workers feed largely on the juices of fruits and vegetables, honeydew, and the flesh of small arthropods.

PARATRECHINA, subgenus NYLANDERIA Emery
Pl. 20, Fig. 76

Prenolepis, subg. *Nylanderia* Emery, 1906, Soc. Ent. de Belg. Ann. **50**:134.
Paratrechina, subg. *Nylanderia* Emery, 1926, *in* Wytsman, Genera Insectorum, fasc. 183, p. 217.
Subgenotype, *Prenolepis vividula* Nylander (by original designation).
Nylander, 1846, Acta Soc. Fennic. **2**:900, illus.
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:948.
Forel, 1884, Soc. Vaud. des Sci. Nat. Bul. **20**:348.
Forel, 1893, Lond. Ent. Soc. Trans., p. 338.
Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:636.
Wheeler, 1903, Psyche **10**:104, illus.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:390.
Forel, 1922, Rev. Suisse de Zool. **30**:98.
Cole, 1940, Amer. Midl. Nat. **24**:66.
Wesson, 1940, Amer. Midl. Nat. **24**:100.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:295.

Length 2-3.4 mm. Body and appendages not extremely long and slender as in the subgenus *Paratrechina*. Antenna 12-segmented, scape considerably surpassing the posterior border of the head, funiculus without a club, antennal fossa inserted very close to posterior border of clypeus but usually separated from it. Eye well-developed. Ocelli usually indistinct or absent. Maxillary palpus 6-segmented, labial palpus 4-segmented. Mandible with distinct teeth. Thorax short, sometimes rather stout. Mesonotum small, more or less distinctly separated from the adjacent regions of the thorax by sutures or impressions. Mesoepinotal region clearly impressed dorsally but without a strong subcylindrical constriction as occurs in *Prenolepis*. A pair of small but distinct spiracles in this region. Base of epinotum much shorter than the declivity. Base of gaster with an impression, often more or less concealing the petiolar scale. Body more or less shining, although often bearing closely appressed, rather dense pubescence. Body with coarse, suberect to erect hairs, these usually present on the scapes and legs but especially the tibiae. Color variable, usually ranging from testaceous through light brown to almost black. Ten forms, *arenivaga* Wheeler, *arenivaga* var. *faisonensis* Forel, †*bourbonica* (Forel) var., †*bruesi* (Wheeler), †*fulva pubens* (Forel), †*parvula* (Mayr), *parvula* var. *grandula* Forel, †*vividula* (Nylander), †*vividula guatemalensis* (Forel), *vividula melanderi* (Wheeler). Members of the genus occur commonly over the eastern half of the United States but are apparently rare,

sporadically distributed or absent in the western half of the country. One of the commonest species is *parvula*. Several forms, such as *fulva pubens* and *bourbonica* var., have been introduced, the former occurring in greenhouses. The ants of this subgenus form small colonies in the soil or in rotting wood. They nest in such diverse places as sea beaches, meadows and open woods. Workers attend honeydew-excreting insects and are also known to invade houses in search of sweets. Although easily recognized generically the ants are difficult to determine specifically. Color and pilosity are variable. As Wheeler has remarked the genital appendages of the male seem to offer the best characters for the separation of the species.

PRENOLEPIS Mayr

Pl. 20, Fig. 77

Prenolepis Mayr, 1861, Die Europäischen Formiciden, p. 52.
Genotype, *Tapinoma nitens* Mayr (by designation of Bingham, 1903).
Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:635.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:390.
Wheeler, 1930, Ent. Soc. Amer. Ann. **23**:1, illus.
Eckert and Mallis, 1937, Univ. Calif. Agr. Expt. Sta. Circ. 342: 27, illus.
*Cole, 1940, Amer. Midl. Nat. **24**:66, 67.
Dennis, 1941, Ent. Soc. Amer. Ann. **34**:82.
Talbot, 1943, Ecology **24**:31-44.

Length 2.2-4 mm. Antenna 12-segmented; scape very long, surpassing the posterior corner of the head by almost one-half its own length; fossa extremely close to or touching the posterior border of the clypeus. No ocelli. Eye prominent, convex, placed closer to the posterior than the anterior border of the head. Frontal area usually more or less indistinct. Maxillary palpus 6-segmented, unusually long. Mandible with oblique masticatory border bearing 5 or 6 teeth. Thorax small, slender, divided into two parts by a remarkably strong constriction of the mesonotum. A pair of prominent spiracles situated in the constriction. Petiolar node strongly inclined, anteroposteriorly compressed, with a transverse, straight or weakly emarginate, superior border. Basal segment of gaster with a strong impression. Gaster, from above, with the basal border meeting each side in a very distinct angle. Tibia without erect hairs. Body smooth and shining, appendages less so because of the pubescence covering them. Seven forms, †*imparis* (Say), *imparis* var. *arizonica* Wheeler, †*imparis* var. *californica* Wheeler, *imparis* var. *coloradensis* Wheeler, †*imparis* var. *minuta* Emery, *imparis* var. *pumila* Wheeler, †*imparis* var. *testacea* Emery. One or more of these are thought to occur in every state. *P. imparis* is commonly found nesting in moist, clay soil, especially that of woodlands. The single entrance to the nest is usually surrounded by coarse, characteristic earthen pellets. For detailed accounts of the nesting habits see Dennis 1941 and Talbot 1943. Workers live largely on the sap of decaying fruits and honeydew. Repletes are not uncommon in the nests. These ants apparently can withstand more cold than any other species in the United States. Workers have been seen above ground when the surface of the ground was frozen and the air temperature below freezing. *P. imparis* is one of the first ants, if not the first, to take its nuptial flights in the spring, usually in March or April. Although workers

sometimes invade houses in search of food, especially sweets, the ants are apparently never as troublesome and persistent pests as the little black ant, *Monomorium minimum* (Buckley), the thief ant, *Solenopsis molesta* (Say), and certain others.

LASIUS, subgenus LASIUS Fabricius
Pl. 21, Fig. 79

Lasius Fabricius, 1804, Syst. Piez., p. 415.
Subgenotype, *Formica nigra* Linnaeus (by designation of Bingham, 1903).
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:637-639.
Pergande, 1900, Wash. Acad. Sci. Proc. **2**:519.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:393.
Forbes, 1908, Univ. Ill. Agr. Expt. Sta. Bul. **131**:1, illus.
Tanquary, 1913, Ill. State Lab. Nat. Hist. Bul. **9**:417-443.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:590-593.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:524-526.
Eckert and Mallis, 1937, Univ. Calif. Agr. Expt. Sta. Circ. 342: 30.
Dennis, 1938, Ent. Soc. Amer. Ann. **31**:295.
Metcalf and Flint, 1939, Destructive and Useful Insects, McGraw-Hill Book Co., 2d ed., pp. 371, 770.
*Cole, 1940, Amer. Midl. Nat. **24**:67.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:296.

Length 2-4 mm. Antenna 12-segmented, without a club; antennal fossa placed very close to or touching the posterior border of the clypeus. Eye well-developed, situated approximately on the posterior half of the side of the head. Maxillary palpus long, 6-segmented, the terminal segments subequal. Ocelli usually present but small and indistinct. Petiolar scale vertical or not strongly inclined, the superior border entire or emarginate. Body varying in color from light brown to blackish. Antennal scapes and tibiae with or without erect hairs. Erect hairs on body ranging from a few to rather abundant. Pubescence closely appressed, usually rather dense but not concealing the surface, especially in some lights. Ants capable of emitting a strong formic acid odor. Three forms, †*niger alienus americanus* Emery, †*niger* var. *neoniger* Emery, and †*niger* var. *sitkaënsis* Pergande. One or more of these have been found in every state. The ants of this subgenus nest in rotten wood, in the soil, or in the soil beneath objects. Although the workers feed to a large extent on the flesh of small arthropods they are also exceedingly fond of honeydew; *americanus*, at least, has proven itself an economic pest through its habit of fostering and spreading plant lice on the roots of corn, cotton, strawberry, and other plants. This species also commonly invades houses. For a detailed account of the habits of *americanus* see Forbes, 1908. The ants of this subgenus vary so greatly in size, color and pilosity that specimens often cannot be placed specifically with complete certainty.

LASIUS, subgenus CHTHONOLASIUS Ruzsky
Pl. 21, Fig. 80

Lasius, subg. *Chthonolasius* Ruzsky, 1912, Kasau Zap. Vet. Inst. **29**:630.
Subgenotype, *Formica flava* Fabricius (by original designation).
Walsh, 1862, Ent. Soc. Phila. Proc. **1**:310.*
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:639-642, illus.

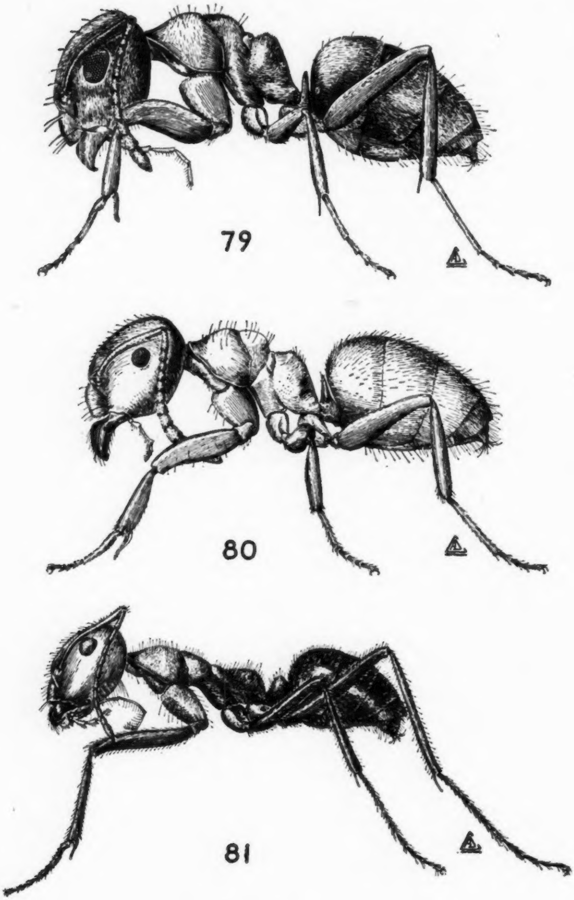


PLATE 21

Fig. 79. *Lasius* (*Lasius*) *niger alienus americanus* Emery, worker.
Fig. 80. *Lasius* (*Chthonolasius*) *umbratus mixtus aphidicola* (Walsh), worker.
Fig. 81. *Myrmecocystus* sp., worker.

Wheeler, 1906, Psyche **13**:38.
*Wheeler, 1910, Psyche **17**:235.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:526-530.
Wheeler, 1917, Psyche **24**:169.
Smith, 1934, Ent. Soc. Amer. Ann. **27**:384.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:296.

Length 1.5-5.5 mm. Maxillary palpus rather long, 6-segmented, the segments more or less decreasing in length toward the apex of palpus. Eye extremely small to moderately small, often hairy. Antennal fossa very close to or touching the posterior border of the clypeus. Apex of scape usually attaining or surpassing the posterior border of the head. Scapes and legs with or without prominent suberect to erect hairs. Petiole erect, rather strongly compressed anteroposterioly, and usually with emarginate superior border. Ocelli indistinct or absent. Base of gaster not concealing the petiole, without an impression or with a very weak one. Hairs in some forms faintly barbed. Pubescence rather dense, closely appressed but not concealing the surface of the body in some lights. Color ranging from sordid white through yellowish brown to deep brown. Twelve forms, †*brevicornis* Emery, †*brevicornis microps* Wheeler, †*flavus claripennis* Wheeler, †*flavus nearcticus* Wheeler, *humilis* Wheeler, *pilosus* M. R. Smith, †*umbratus epinotalis* Buren, †*umbratus minutus* Emery, †*umbratus mixtus aphidicola* (Walsh), †*umbratus speculiventris* Emery, †*umbratus subumbratus* Viereck, *umbratus vestitus* Wheeler. One or more of these occur in every state. One of the most common is *umbratus mixtus aphidicola*. *L. vestitus* and *L. umbratus subumbratus* seem to be boreal in distribution. The ants of this subgenus nest in rotten logs and stumps, in the soil, or in the soil beneath stones and logs. *L. umbratus minutus* commonly nests in bogs where it constructs mounds several feet broad and 1 to 2 feet high. The workers of *Chthonolasius* live largely on honeydew obtained from subterranean plant lice and mealybugs. It appears that some of the *umbratus* forms (*subumbratus*, at least) are temporary parasites in the colonies of other forms of *Lasius*, such as *niger alienus americanus* and *niger* var. *sitkaensis*. The fertilized female of *subumbratus* secures adoption in the colonies of these ants by some means or other. The host ants finally disappear and are replaced by the pure colony of the invading female. For a more detailed account see Wheeler, 1917, in Psyche.

LASIUS, subgenus ACANTHOMYOPS Mayr

Pl. 20, Fig. 78

Acanthomyops Mayr, 1862, Zool.Bot. Gesell. Wien, Verh. **12**:699.
Subgenotype, *Formica clavigera* Roger (by designation of Wheeler, 1911).
Walsh, 1862, Ent. Soc. Phila. Proc. **1**:311.
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:950.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:637, 638, 642.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:367.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:83.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:591, 592, 594.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:530-533.
Smith, 1934, Psyche **41**:213.
*Cole, 1940, Amer. Midl. Nat. **24**:68, 70, 72.
Buren, 1941, Iowa State Col. Jour. Sci. **15**:231, illus.

Buren, 1942, Iowa State Col. Jour. Sci. **16**:405.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:296.

Length 2.5-5 mm. Body somewhat robust. Antenna 12-segmented, fossa extremely close to or touching posterior border of clypeus, funiculus slightly to strongly enlarged from base to apex. Ocelli absent or indistinct. Eye very small to small. Maxillary palpus short, 3-segmented, labial palpus 4-segmented. Mesoepinotal region with a prominent constriction in which there is a pair of distinct dorsal spiracles. Petiole erect in profile, usually rather thin, occasionally thick, with emarginate or rounded superior border. Base of gaster not concealing petiole, and usually without a distinct impression. Body rather shining, usually varying in color from pale yellowish to dark yellowish red. Suberect to erect hairs generally rather abundant on body but absent on scapes. Hairs in most species finely barbed (in *plumopilosus* Buren distinctly plumose toward the apex). Thirteen forms, †*claviger* (Roger), †*claviger subglaber* Emery, †*clavigeroides* Buren, †*interjectus* Mayr, †*interjectus arizonicus* Wheeler, *interjectus californicus* Wheeler, *interjectus coloradensis* Wheeler, †*latipes* (Walsh), †*murphyi* Forel, *occidentalis* Wheeler, †*parvulus* M. R. Smith, †*plumopilosus* Buren, † *pubescens* Buren. One or more of these occur in every state. The two best known are *interjectus* and *claviger*. The latter form is peculiar in possessing dimorphic females. The ants of this subgenus can be distinguished from other North American ants by the pleasant, lemon-verbena odor they exude. The species nest in rotting wood and in the soil, often under stones or other objects. They are subterranean in habit, depending for food largely, if not entirely, on honeydew obtained from underground plant lice and mealybugs, which they foster. Occasionally such species as *claviger* and *interjectus* nest around or beneath the basement walls and floors of houses and become especially objectionable by giving off numerous winged females and males which enter the basements through breaks in the mortar. Housekeepers often mistake these for termites.

MYRMECOCYSTUS Wesmael

Pl. 21, Fig. 81

Myrmecocystus Wesmael, 1838, Brussels, Acad. Roy. des Sci. de Belg. Bul. **5**:766.
Subgenotype, *Myrmecocystus mexicanus* Wesmael (monobasic).
Wesmael, 1838, Brussels, Acad. Roy. des Sci. de Belg. Bul. **5**:766.
McCook, 1881, Acad. Nat. Sci. Phila. Proc. [33]: 17, illus.
Forel, 1886, Soc. Ent. de Belg. Ann. **30**:202.
Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:666.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:135.
Wheeler, 1908, Amer. Mus. Nat. Hist. Bul. **24**:345, illus.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:98-99.
*Wheeler, 1912, Psyche **19**:172, illus.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., pp. 366-371, illus.
Parks, 1929, Brooklyn Ent. Soc. Jour. **24**:32.
Cole, 1936, Ent. News **47**:118.
Cole, 1938, Amer. Midl. Nat. **19**:678.
*Cole, 1942, Amer. Midl. Nat. **28**:385.

Length 2,2-9 mm. (replete of *mexicanus* 10-13 mm.). Polymorphism weakly to strongly developed. General habitus of a *Formica*. Antenna 12-

segmented; antennal fossa placed close to or touching posterior border of clypeus, funiculus slender, without a club. Eye convex, placed posterior to the middle of the side of the head. Ocelli varying from absent or indistinct to distinct. Maxillary palpus unusually long, 6-segmented, the 4th segment at least as long as, or longer than, the 2 succeeding segments combined. Psammophore present. Apical tooth of mandible long, acute. Frontal carinae subparallel. Mesoepinotal region somewhat constricted, saddle-shaped. Petiolar scale erect, usually thick anterposteriorly, and with blunt superior border. Body, especially the gaster, clothed with dense, appressed pubescence, usually also with numerous erect hairs which are present even on the scapes and legs. Twenty-two forms, *hammettensis* Cole, *lugubris* Wheeler, †*melliger* Forel, *melliger depilis* Forel, *melliger lomoaënsis* Wheeler, *melliger mendax* Wheeler, *melliger mendax comatus* Wheeler, † *melliger mimicus* Wheeler, *melliger mimicus californicus* Cole, *melliger mimicus jesuita* Wheeler, †*melliger orbiceps* Wheeler, †*melliger semirufus* Emery, *melliger semirufus romainei* Cole, †*melliger semirufus kennedyi* Cole, † *melliger semirufus testaceus* Emery, †*mexicanus* Wesmael, †*mexicanus* var. *hortideorum* McCook, †*mexicanus idahoensis* Cole, †*mexicanus mojave* Wheeler, †*mexicanus navajo* Wheeler, *yuma* Wheeler, *yuma* var. *flaviceps* Wheeler. One or more of these have been found in Texas, Oklahoma, New Mexico, Colorado, Arizona, Utah, Idaho, California and Kansas. According to Wheeler, 1908, p. 346, our forms occur in the warm, arid plains and deserts; *melliger* being more abundant at altitudes of 300-1,500 meters and *mexicanus* finding its best environment at altitudes of 2,000-3,000 meters. The ants are called honey ants because of the honeylike substance stored in the gaster of the repletes. The workers of some forms, at least, forage at night. Although they are carnivorous their food consists to a large extent of the sweet excretions derived from plants and the honeydew obtained from insects. They nest in the soil in colonies of only a few hundred individuals or less. Although the worker bears a striking resemblance to that of a *Formica* it can be distinguished by the shape of the eyes, length and form of the maxillary palpus, presence of a psammophore, shape of thorax and petiole, and other characters.

FORMICA, subgenus PROFORMICA Ruzsky
Pl. 22, Fig. 83

Formica, subg. *Proformica* Ruzsky, 1903, Soc. Ent. Ross. Horae **36**:303.
Subgenotype, *Formica nasuta* Nylander (by designation of Wheeler, 1911).
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:661, 664.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:536-542.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:599.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:554.
Cole, 1942, Amer. Midl. Nat. **28**:384.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:299, 308.

Small for a *Formica* (2.5-5.5 mm.). Rather smooth and shining. Head narrowed anteriorly, with rounded posterior border and rounded posterior corners. Antenna 12-segmented, scape flattened, the first funicular segment approximately as long as the two succeeding segments combined. Frontal carinae short, subparallel. Clypeus sharply carinate, the anterior border somewhat extended in the middle. Epinotum often with the base and de-

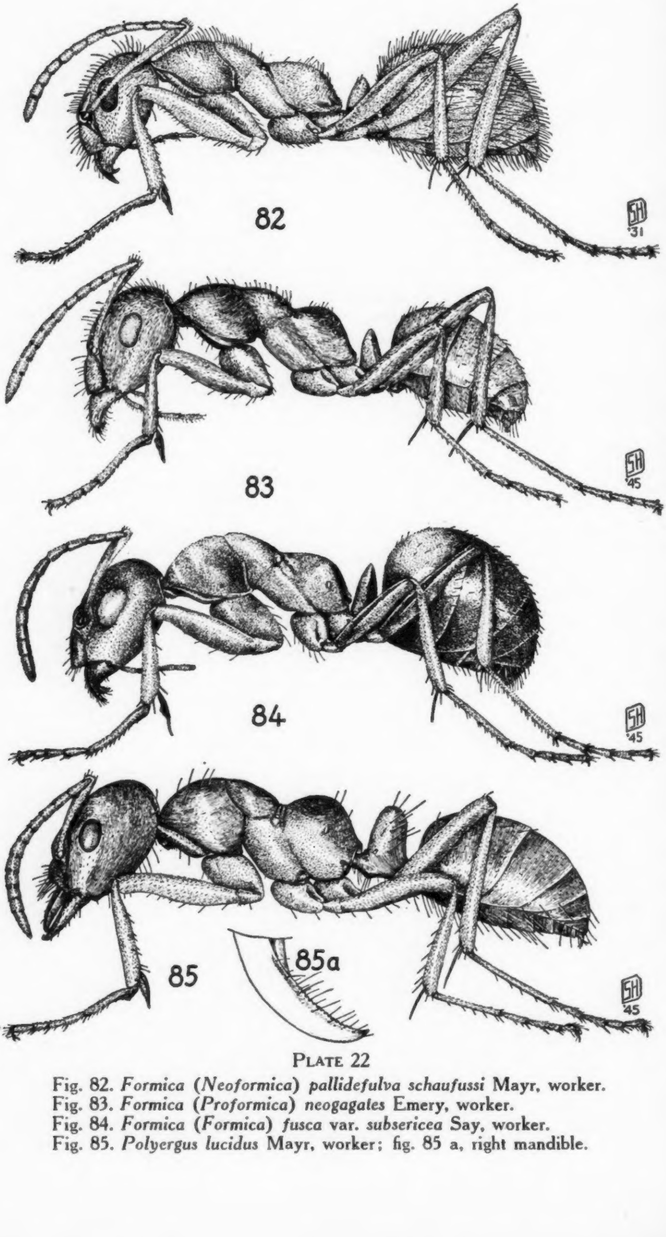


PLATE 22

Fig. 82. *Formica (Neoformica) pallidefulva schaufussi* Mayr, worker.
Fig. 83. *Formica (Proformica) neogagates* Emery, worker.
Fig. 84. *Formica (Formica) fusca* var. *subsericea* Say, worker.
Fig. 85. *Polyergus lucidus* Mayr, worker; fig. 85 a, right mandible.

clivity not clearly defined. Petiole convex anteriorly, more flattened posteriorly, with transversely rounded, usually entire, superior border. Pubescence often sparse. Erect hairs present on gula, head, thorax, petiole and gaster. Antennal scape with or without erect hairs. Head and sections of the thorax often with a delicate sculpturing which does not obscure the shining appearance of these parts. General color ranging from reddish or brownish to almost black, the gaster often darker than the rest of the body. One or more forms have been recorded from almost every state except those entirely south of the 35th degree of latitude from South Carolina to New Mexico. Six forms, *limata* Wheeler, †*neogagates* Emery, †*neogagates lasioides* Emery, † *neogagates lasioides vetula* Wheeler, *neogagates* var. *morbida* Wheeler, †*neogagates* var. *vinculans* Wheeler. The most common is *neogagates* and several of its variants. The ants of this subgenus form small colonies in the soil, usually beneath stones or other objects. Wheeler, 1913, p. 538, states that *neogagates* nests from sea level to altitudes of at least 6,000 to 8,000 feet. The food of the workers of *Proformica* is undoubtedly the flesh of small arthropods supplemented by honeydew. The ants are enslaved by various forms in the Sanguinea group. Workers are sometimes infected with the parasitic fungus, *Laboulbenia formicarum* Thaxter. This subgenus contains some of our smallest *Formica*.

FORMICA, subgenus NEOFORMICA Wheeler

Pl. 22, Fig. 82

Formica, subg. *Neoformica* Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:548.
Subgenotype, *Formica pallidefulva* Latreille (by designation of Wheeler, 1913).
Latreille, 1802, Hist. Nat. Fourmis, p. 174.
Mayr, 1866, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. **53**:493, illus.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:654, illus.
*Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:369.
Wheeler, 1906, Amer. Mus. Nat. Hist. Bul. **22**:343.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:548-560.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:598.
Cole, 1938, Amer. Midl. Nat. **20**:369.
Smith, 1939, Ent. Soc. Amer. Ann. **32**:583.
Wesson and Wesson, 1940, Amer. Midl. Nat. **24**:102.
*Cole, 1942, Amer. Midl. Nat. **24**:385.
Cole, 1943, Amer. Midl. Nat. **29**:184.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:299, 309.

Length 4-7 mm. Head, excluding mandibles, noticeably longer than broad (usually one and two-tenths to one and three-tenths times as long as broad), narrowed anteriorly, with rounded posterior border and rounded posterior corners. Antennal scape slender, weakly curved at the base, approximately one and one-fourth to one and one-third times the length of the head; first funicular segment distinctly shorter than the two succeeding segments combined. Frontal carinae subparallel in the *pallidefulva* forms. Clypeus rather sharply carinate, with the anterior border extended in the middle. Maxillary palpus 6-segmented. Thorax slender, the promesonotum not very strongly convex and the mesoepinotal impression usually not very deep. Epinotum low, base and declevity not clearly delimited in the *pallidefulva* forms. Petiole erect, with rather strongly convex anterior surface and more

weakly convex or flattened posterior surface, the superior border transversely rounded, often more or less blunt. Pubescence in the *pallidefulva* forms variable but never dense on the head and thorax; pilosity ranging from sparse to rather abundant, with erect hairs always absent from the antennal scapes and present or absent on the gula. Body in the *pallidefulva* forms (excepting *archboldi*) more or less shining, especially the head and thorax; rather subopaque in the *moki* forms. General color ranging from pale yellowish through reddish brown to almost black, the gaster often darker than the head and thorax. Twelve forms, †*moki* Wheeler, *moki grundmanni* Cole, †*moki xerophila* M. R. Smith, †*pallidefulva* Latreille, †*pallidefulva archboldi* M. R. Smith, †*pallidefulva delicata* Cole, †*pallidefulva nitidiventris* Emery, †*pallidefulva nitidiventris fuscata* Emery, †*pallidefulva schaufussi* Mayr, *pallidefulva schaufussi dolosa* Wheeler, †*pallidefulva schaufussi incerta* Emery, †*pallidefulva* var. *succinea* Wheeler. The *pallidefulva* forms have been recorded from New Mexico to Wyoming and eastward to the Atlantic Ocean. Members of the Moki group are known only from Arizona, Utah, and Washington, but may occur in some of the other Western States. The ants of this subgenus form small to moderately large colonies in the ground, either freely exposed or beneath stones and other objects. Their food is mainly the flesh of arthropods and honeydew. The *pallidefulva* forms are enslaved by various *Polygerus* and members of the *Formica sanguinea* group. *F. pallidefulva* in the broad sense is easily recognized but its many variants are often extremely difficult to determine because of variations in size, color, and pilosity. The parasitic fungus, *Laboulbenia formicarum* Thaxter often infects workers of the *pallidefulva* forms.

FORMICA, subgenus FORMICA Linnaeus

Pl. 22, Fig. 84

Formica Linnaeus, 1758, System. Naturae Ed. 10, **1**:579.

Subgenotype, *Formica rufa* Linnaeus (by designation of Curtis, 1839).

This is the largest subgenus of *Formica*. It contains 107 of the 122 forms and is so large and unwieldy that for the sake of convenience it has been divided into 5 groups, called the Exsecta, Rufa, Microgyna, Fusca and Sanguinea groups. The characters employed for delimiting these groups, although the best known, are not always entirely satisfactory, because the ants composing an individual group are rather variable wtih respect to many of the characters. A novice attempting identification may therefore be easily led astray. Members of the Sanguinea group can usually be readily recognized by the emargination of the anterior border of the clypeus and those of the Exsecta group by the emarginate posterior border of the head. Members of the remaining groups are often placed with much more difficulty.

1. Posterior border of head with a pronounced emargination. Superior border of mandible often bearing small denticulae. Petiole with sharp superior border. Gaster usually darker than the head and thorax, and often shining ....Exsecta group, p. 624

   One or more characters unlike alternative 2

2. (1) Anterior border of clypeus with a more or less distinct to a very pronounced median emargination ....Sanguinea group, p. 624

   Anterior border of clypeus entire, rounded or subangularly produced in the middle.... 3

3. (2) Body robust (subopaque); color usually light to dark red with brown or black gaster 4

Body more slender. Color diverse, often brown or black. Pubescence varying from moderate to abundant ....Fusca group, p. 621

4. (3) Female larger than the largest worker, usually 6 mm. or more in length ....Rufa group, p. 622

Female not larger than the largest worker (often smaller than the largest worker). Ants noted for parasitizing colonies of other *Formica* ......Microgyna group, p. 623

FUSCA GROUP

Pl. 22, Fig. 84

Say, 1836, Boston Jour. Nat. Hist. **1**:289.
Buckley, 1866, Ent. Soc. Phila. Proc. **6**:156.
Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:426.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:657-661, 663, 664.
Wheeler, 1902, Amer. Nat. **36**:947.
*Emery, 1909, Deut. Ent. Ztschr., p. 193.
Wheeler, 1912, Psyche **19**:90.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:494-536, illus.
Santschi, 1913, Soc. Ent. de Belg. Ann. **57**:435.
Wheeler, 1915, Psyche **22**:205.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:598.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:545-553.
Kennedy and Dennis, 1937, Ent. Soc. Amer. Ann. **30**:542.
*Cole, 1940, Amer. Midl. Nat. **24**:77-79.
*Cole, 1942, Amer. Midl. Nat. **28**:381.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:300.

Length 2.5-7.5 mm. For characters see the key. This group contains 28 forms, †*cinerea* var. *altipetens* Wheeler, †*cinera* var. *canadensis* Santschi, *cinerea* var. *lepida* Wheeler, †*cinerea* var. *neocinerea* Wheeler, *cinerea* var. *rutilans* Wheeler, †*fusca* Linnaeus, *fusca* var. *algida* Wheeler, †*fusca* var. *argentea* Wheeler, *fusca* var. *blanda* Wheeler, †*fusca* var. *gelida* Wheeler, *fusca* var. *glacialis* Wheeler, †*fusca* var. *marcida* Wheeler, †*fusca* var. *neoclara* Emery, †*fusca* var. *neorufibarbis* Emery, †*fusca pruinosa* Wheeler, *fusca pruinosa lutescens* Wheeler, †*fusca* var. *subaenescens* Emery, †*fusca* var. *subsericea* Say, †*hewitti* Wheeler, †*lecontei* Kennedy and Dennis, †*montana* Emery, †*pilicornis* Emery, †*rufibarbis* var. *gnava* Buckley, †*rufibarbis* var. *occidua* Wheeler, †*sibylla* Wheeler, †*subpolita* Mayr, †*subpolita* var. *camponoticeps* Wheeler, and *subpolita* var. *ficticia* Wheeler. One or more of these occur in every state of the Union with the possible exception of Florida. The majority of the forms are included under *fusca*, its one subspecies and 11 varieties, *subpolita* and its 2 varieties, and the 5 varieties of *cinerea*. As previously mentioned some of the forms of the group are enslaved by *Polyergus*, and by *Formica* of the Sanguinea group. Although a great many of the forms in the Fusca group have more or less dark brown or black bodies there are some at least which have a color approaching that of the ants in some of the other Formica groups. The ants of the Fusca group nest in the soil either freely or under cover of stones, logs, and other objects. The workers are carnivorous as well as feeders on honeydew. The common *subsericea* often builds unsightly mounds on lawns in some regions.

RUFA GROUP

Nylander, 1856, Sci. Nat. Zool. Ann. **5**:62.
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:951.
Forel, 1886, Soc. Ent. de Belg. Bul. (C. R.) **30**:39.
Mayr, 1886, Zool.-Bot. Gesell. Wien, Verh. **36**:428.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:649-652, 663, illus.
Wheeler, 1903, Amer. Mus. Nat. Hist. Bul. **19**:391, 395, 460, 639-645.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:374.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:268-269.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:85.
Wheeler, 1912, Psyche **19**:90.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:425-465, 560, illus.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:595.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:535-542.
*Burrill and Smith, 1919, Ohio Jour. Sci. **19**:286.
Abbott, 1926, Ent. News **37**:210.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 444.
Cole, 1932, Psyche **39**:30, illus.
Weber, 1935, Ecolog. Monograph **5**:165, illus.
Kennedy and Dennis, 1937, Ent. Soc. Amer. Ann. **30**:531, illus.
*Creighton, 1940, Amer. Mus. Novitates No. 1055: 10 pp., illus.
Buren, 1942, Iowa State Col. Jour. Sci. **16**:402.
*Cole, 1942, Amer. Midl. Nat. **28**:379-381, illus.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:300, 301-303.

Length 3-9 mm. Workers of many species robust in stature. For other characters see key. This group includes many forms with light to dark red head, thorax and petiole, and dark brown to black gaster. In some species the head, thorax and even the petiole are infuscated. Pilosity highly variable, ranging from no hairs on the thorax and petiole to abundant hairs on these regions and the remainder of the body. There are 31 forms, †*ciliata* Mayr, *comata* Wheeler, †*criniventris* Wheeler, †*dakotensis* Emery, *dakotensis* var. *montigena* Wheeler, *dakotensis* var. *saturata* Wheeler, *dakotensis* var. *specularis* Emery, *ferocula* Wheeler, *foreliana* Wheeler, †*fossaceps* Buren, †*oreas* Wheeler, †*oreas* var. *comptula* Wheeler, †*prociliata* Kennedy and Dennis, †*rufa clivia* Creighton, †*rufa coloradensis* Wheeler, †*rufa gymnomma* Wheeler, †*rufa haemorrhoidalis* Emery, †*rufa integra* Nylander, †*rufa integroides* Emery, *rufa laeviceps* Creighton, †*rufa melanotica* Emery, *rufa mucescens* Wheeler, †*rufa obscuripes* Forel, †*rufa obscuriventris* Mayr, †*rufa planipilis* Creighton, †*rufa propinqua* Wheeler, *rufa ravida* Wheeler, *rufa subcaviceps* Wheeler, †*rufa subfasciata* Wheeler, *rufa subnitens* Creighton, †*rufa tahoensis* Wheeler. One or more occur in every state with the possible exception of Florida. In the eastern half of the United States the two most common forms are *rufa integra* and *rufa obscuriventris.* One of the most widely distributed and best known is *rufa obscuripes,* the western mound thatching ant. The inquilinous ant, *Leptothorax diversipilosus* M. R. Smith, has been found nesting in the colonies of *obscuripes* and *melanotica.* Many of the members of the Rufa group are temporary parasites on other forms of *Formica* belonging to the Fusca group and the subgenus *Neoformica,* but especially the former. Since the biology of many of the ants is not known there may be more temporary parasites and hosts than those listed. The ants of this group nest in rotten logs and

stumps, or in the soil. Their nests in the soil are usually below objects. In most instances the surface of the nest is covered with vegetable detritus. Colonies are often large with strongly aggressive workers. The food of the ants is similar to that of other *Formica.*

MICROGYNA GROUP

*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:651, illus.
Wheeler, 1903, Amer. Mus. Nat. Hist. Bul. **19**:645, illus.
Wheeler, 1904, Amer. Mus. Nat. Hist. Bul. **20**:347.
Forel, 1904, Soc. Ent. de Belg. Ann. **48**:152.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:270-274.
Wheeler, 1906, Psyche **13**:39, illus.
Wheeler, 1909, N. Y. Ent. Soc. Jour. **17**:84.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:465-481, illus.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:597.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:542-544.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., pp. 414-444, illus.
Kennedy and Dennis, 1937, Ent. Soc. Amer. Ann. **30**:536-542, illus.
Cole, 1939, Amer. Midl. Nat. **22**:413, illus.
*Cole, 1940, Amer. Midl. Nat. **24**:76.
Cole, 1940, Amer. Midl. Nat. **23**:224.
*Cole, 1942, Amer. Midl. Nat. **28**:381.
Buren, 1942, Iowa State Col. Jour. Sci. **16**:399.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:300, 303.

Length 3.3-6.5 mm. Differing from the Rufa group mainly in that the female is approximately as small as, or even smaller than the worker. For other characters see the key. Twenty-five forms, †*difficilis* Emery, †*difficilis* var. *consocians* Wheeler, †*habrogyna* Cole, †*impexa* Wheeler, *indianensis* Cole, †*knighti* Buren, †*microgyna* Wheeler, †*microgyna californica* Wheeler, †*microgyna californica hybrida* Wheeler, †*microgyna rasilis* Wheeler, †*microgyna rasilis pinetorum* Wheeler, *microgyna rasilis pullula* Wheeler, †*microgyna rasilis spicata* Wheeler, *microgyna* var. *recidiva* Wheeler, *microgyna scitula* Wheeler, †*microgyna spatulata* Buren, †*morsei* Wheeler, †*nepticula* Wheeler, *nevadensis* Wheeler, †*postoculata* Kennedy and Dennis, †*querquetulana* Kennedy and Dennis, *reflexa* Buren, *whymperi* Forel, *whymperi* var. *adamsi* Wheeler, *whymperi* var. *alpina* Wheeler. The distribution of the forms in this group is imperfectly known due to the sparsity of records. One or more forms are believed, however, to occur in every state with the possible exception of Florida and some of the Gulf States. The small size of the female readily suggests that the ants are temporary parasites on other *Formica.* Wheeler has shown that the female of *difficilis* var. *consocians* secures adoption in the nests of *pallidefulva schaufussi incerta* and that the workers of *incerta* rear the progeny of *consocians* until the *incerta* workers die off and a pure colony of the parasite remains. The method or methods employed by the *consocians* female in obtaining adoption is not known. Other *Formica* believed to act as hosts are those of the Fusca group and of the subgenus *Proformica;* there may be others. Nests of the ants of the Microgyna group are mostly constructed in the soil beneath objects and the surface of the nest covered with vegetable detritus. Buren has recorded free nests in the soil except for the covering of vegetable detritus. In the Eastern States *difficilis*

is one of the most common forms. The food of the ants of this group is the same as that of other *Formica*. The entire group is very much in need of some very careful biological and taxonomic work.

EXSECTA GROUP

McCook, 1877, Amer. Ent. Soc. Trans. **6**:295, illus.
Forel, 1886, Soc. Ent. de Belg. Bul. (C. R.) **30**:38.
*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:653.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:481-489, illus.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:544-545.
Andrews, 1926, Psyche **33**:127.
Andrews, 1928, Amer. Nat. **62**:63.
Holmquist, 1938, Ecology **9**:70.
Andrews, 1929, Ent. Soc. Amer. Ann. **22**:369.
Park, 1929, Ent. News **40**:325-326.
Dreyer and Park, 1932, Psyche **39**:127.
*Cole, 1940, Amer. Midl. Nat. **24**:75, illus.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:300, 307.

Length 3.5-7.5 mm. Antenna 12-segmented. Scape flattened. Posterior border of head distinctly emarginate, the emargination broad but not always deep. Clypeus carinate, the anterior border projecting in the middle. Frontal carinae diverging posteriorly. Superior border of mandible often with small denticulae. Petiole with a sharp superior border. Gaster generally darker than the head and thorax and often shining. Erect hairs sparse or absent on head and thorax of all forms of *exsectoides* except *opaciventris*. Six forms, †*exsectoides* Forel, †*exsectoides* var. *davisi* Wheeler, *exsectoides* var. *hesperia* Wheeler, †*exsectoides opaciventris* Emery, †*ulkei* Emery, †*ulkei* var. *hebescens* Wheeler. The distribution of these ants is not well known. One or more forms have been found in the region from Maine to Georgia and westward to Colorado and Wyoming. The best known is perhaps the Allegheny mound building ant, *exsectoides,* whose mounds often reach enormous proportions and contain many thousands of individuals. Wheeler has shown that the females of *exsectoides* establish their colonies by temporarily parasitizing small colonies of *Formica fusca* var. *subsericea*. A number of investigators have found that the workers of *exsectoides* can destroy small trees and other growth by attacking the bark and cambium layer. The workers are very aggressive. The food of the ants is the flesh of small arthropods supplemented by honeydew and the sap of plants.

SANGUINEA GROUP

*Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:646-649, illus.
Forel, 1901, Soc. Ent. de Belg. Ann. **45**:395.
Wheeler, 1905, Amer. Mus. Nat. Hist. Bul. **21**:1.
*Wheeler, 1913, Harvard Univ. Mus. Compar. Zool. Bul. **53**:401-425.
*Wheeler, 1916, Conn. State Geol. and Nat. Hist. Surv. Bul. **22**:595.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:533-535.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 452, illus.
Creighton, 1935, Amer. Mus. Novitates No. 773, p. 1, illus.
Cole, 1938, Amer. Midl. Nat. **20**:368.
*Cole, 1940, Amer. Midl. Nat. **24**:74.

*Cole, 1942, Amer. Midl. Nat. **28**:375-378.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:299, 307.

Length 3-8 mm. Anterior border of clypeus with a more or less indistinct to a very pronounced median emargination. Body rather stout in the subspecies and varieties of *sanguinea.* Head and thorax usually of a general reddish color with the gaster darker (this color also present in some of the forms in other groups, especially the Rufa and Microgyna groups). Pilosity variable, very sparse or absent on the thorax and petiole of *sanguinea aserva* and *sanguinea subnuda* but rather abundant in *perpilosa* and *obtusopilosa.* The Sanguinea group comprises 17 forms, †*bradleyi* Wheeler, *curiosa* Creighton, *emeryi* Wheeler, †*manni* Wheeler, †*obtusopilosa* Emery, *obtusopilosa* var. *alticola* Wheeler, †*oregonensis* Cole, *pergandei* Emery, †*perpilosa* Wheeler, †*sanguinea aserva* Forel, †*sanguinea puberula* Emery, †*sanguinea rubicunda* Emery, *sanguinea rubicunda sublucida* Wheeler, †*sanguinea subintegra* Emery, *sanguinea subintegra gilvescens* Wheeler, †*sanguinea subnuda* Emery, *wheeleri* Creighton. The ants of this group are widely distributed over the United States and probably occur in every state with the possible exception of Florida. Although no forms have been recorded from Georgia, Alabama, Mississippi and Louisiana there is reason to believe they may occur in the more northern section of these states. Some of the best known forms of *sanguinea* are *rubicunda, subintegra* and *subnuda.* The ants are called facultative slave makers because they are not entirely dependent on their slaves as are the obligatory slave makers, the forms of *Polyergus.* Some forms apparently do not have slaves at all, and others can live part of their life, at least, free of slaves. Their slaves are members of the subgenera *Proformica* and *Neoformica* and the Fusca group of *Formica (Formica).* The ants form moderate-sized colonies in the soil freely exposed or else beneath the cover of stones and other objects. Their food consists largely of the flesh of other small arthropods, honeydew and the brood they appropriate of other *Formica.* Although ordinarily the members of this group are not considered as living in arid regions there are at least two forms, *perpilosa* and *manni,* capable of doing this. Wheeler assigned *bradleyi* to the Sanguinea group, but this ant has some characters which are strongly suggestive of the subgenus *Proformica.*

POLYERGUS Latreille

Pl. 22, Fig. 85

Polyergus Latreille, 1804, Nouv. Dict. Hist. Nat. **14**:179.
Genotype, *Formica rufescens* Latreille (monobasic).
Mayr, 1870, Zool.-Bot. Gesell. Wien, Verh. **20**:952.
Emery, 1893, Zool. Jahrb., Abt. f. System. **7**:666.
Wasmann, 1901, Allg. Ztschr. f. Ent. Neudamm **6**:353.
Burrill, 1908, N. Y. Ent. Soc. Jour. **16**:144.
Santschi, 1911, Soc. Ent. Ital. Bol. **41**:7.
Wheeler, 1915, Amer. Mus. Nat. Hist. Bul. **34**:419-420.
Wheeler, 1916, N. Y. Ent. Soc. Jour. **24**:107.
Wheeler, 1917, Amer. Acad. Arts and Sci. Proc. **52**:555.
Wheeler, 1926, Ants, Columbia Univ. Press, 2d ed., p. 471.
Jones, 1943, Amer. Midl. Nat. **29**:185.
*Buren, 1944, Iowa State Col. Jour. Sci. **18**:310.

Length 4-7 mm. Habitus somewhat similar to that of *Formica*. Antenna 12-segmented, scape rather abruptly enlarged toward the apex, antennal fossa either touching the posterior border of the clypeus or inserted exceedingly close to it. Ocelli distinct. Eye well-developed, convex, placed more than its greatest diameter from the base of the mandible. Frontal carinae short. Clypeus short, with a truncate or broadly but not deeply excised anterior border. Maxillary palpus 4-segmented, labial palpus 2-segmented. Mandible narrow, falcate, with pointed apex; internal border minutely serrated. Thorax stout, with a strong mesoepinotal impression in which is a pair of distinct protuberant spiracles. Petiole erect, unusually stout, generally with a somewhat transversely rounded superior border. Hairs rather sparse on body, especially the thorax. Eight forms, †*lucidus* Mayr, *lucidus montivagus* Wheeler, †*rufescens bicolor* Wasmann, †*rufescens breviceps* Emery, *rufescens breviceps fusciventris* Wheeler, *rufescens breviceps silvestrii* Santschi, *rufescens breviceps umbrata* Wheeler, *rufescens laeviceps* Wheeler. Members no doubt occur in every state with the possible exception of those states bordering the Gulf of Mexico where the ants are either rare or absent. *P. lucidus* is the most common form in the eastern section of the United States. Subspecies and varieties of *rufescens* occur in the Middle West and West, *breviceps* being perhaps the most common form. *Polyergus* workers raid the nests of *Formica* belonging to the subgenera *Neoformica* and *Formica*. Their attention in the last-mentioned subgenus is especially confined to the Fusca group. The *Polyergus* workers appropriate the *Formica* brood for food and those members of the brood which are not eaten develop into slave workers in the *Polyergus* nests. The slaves nurse the brood of the slave makers, repair their nests and feed the *Polyergus* adults.

Glossary

For interpretation of symbols such as *, †, and illus. see pages 5 and 8.

abdominal pedicel, the one or two reduced basal segments of the abdomen between the epinotum and gaster.

anal glands, glands near the anus of worker and female dolichoderine ants which produce a sticky secretion with a disagreeable odor. The secretion is often ejected on other ants as a means of offense or defense.

antennal funiculus, the flexible portion of the antenna distal to the scape. It may be composed of a variable number of segments.

antennal insertion, the place where the antenna is articulated to the head.

antennal fossa, the concavity or socket into which the base of the antenna is articulated to the head.

anterodorsal, toward the front and back.

anterolateral, toward the front and side.

anteroposterior, from the front toward the rear.

anteroventral, toward the front and lower surface (venter).

basal surface of epinotum, the dorsal surface of the epinotum to its junction with the epinotal declivity.

bristle, a coarse, stiff hair.

calyx, a section of the proventriculus with such definite anatomical structures that the structures can often be used for the purpose of taxonomic classification.

carina, a ridge.

cheek, the region on the side of the head between the mandible and compound eye.

cloacal orifice, the anal opening.

crenated, scalloped with small, blunt teeth.

conulate, cone-shaped.

denticulae, small teeth.

depauperate, impoverished or starved.

ecarinate, without carina.

edentate, toothless; without teeth.

emarginate, notched.

epinotal declivity, the sloping, posterior surface of the epinotum.

epinotal tubercle, a small, elevated, triangular structure borne on each side of the epinotum near where the base and declivity meet.

epinotum, usually designated as the area of the thorax lying posterior to the mesonotum; in reality, it represents the area resulting from a fusion of the first abdominal segment with the metathorax.

ergataner, see ergatoid male.

ergatogyne, an individual with structures common to both worker and female.

ergatoid female, see ergatogyne.

ergatoid male, an individual with structures common to both worker and male.

extensor surface of leg, the anterior surface of the leg.

female, the active reproducing unit of the colony, commonly designated as "queen." The female differs from the workers in many morphological structures. Also see page 522 of the introduction.

flexor surface of leg, the posterior surface of the leg.

front, the region of the head lying between the frontal carinae posterior to the clypeus and extending indefinitely toward the vertex and temples.

frontal area, the small, usually triangular area between the frontal carinae directly posterior to the clypeus.

frontal carina, the longitudinal ridge lying on the inner side of the insertion of the antenna.

frontal groove, the impressed longitudinal line extending through the median groove of the head from the frontal area toward the median ocellus.

frontal lobe, the platelike extension of the frontal carina above the insertion of the antenna.

funicular club, the enlarged apical segment or segments of the funiculus, which singly or together form a more or less distinct club.

gaster, the section of the abdomen posterior to the petiole in ants with a single-segmented petiole, and posterior to the postpetiole in ants with a two-segmented petiole.

gula, the ventral surface of the head which is bounded in front by the labium, on the sides by the cheeks, and extends posteriorly to the occipital foramen.

humeral angles of thorax, the anterolateral corners of the prothorax.

humerus, relating to the shoulder.

hypogaeic, subterranean.

inferior angle of head, the anterolateral corner.

inferior angle of prothorax, the angle at the lower anterolateral corner of the prothorax.

infraspinal lamella, a platelike structure beneath the epinotal spine.

inquiline, an individual, especially one of certain Hymenoptera, that lives habitually in the nest or abode of some other species without causing inconvenience to the host other than consuming some of its food; a guest.

lateral spur, the spur on the tibia nearest the exterior surface of the leg.

lyrate, lyre-shaped.

marginate, bounded by an elevated border.

masticatory border, chewing border.

median spur, the tibial spur nearest to the body.

mesoepinotal suture, the suture separating the mesonotum from the epinotum.

metasternal angle or spine, the angle or spine at the lower posterolateral corner of the thorax.

monomorphic, having only one form. (For more detailed explanation see page 522 of introduction.)

nodiform, in the form of a knot or knob.

occipital lobe, the prominent posterolateral corner of the head.

petiole, a pedicel composed of only one segment, or the first segment of a two-segmented pedicel.

pile, hair; applied to the longer and usually coarser, more erect hairs of the body and appendages in contrast to pubescence.

piligerous, bearing hair.

polymorphic, with several different forms. (For more detailed explanation see page 522 of introduction.)

porrect, extended horizontally, stretched out.

posteromesially, directed toward the rear and middle.

promesonotal suture, the suture separating the pronotum from the mesonotum.

proventriculus, the portion of the alimentary canal preceding the true stomach or ventriculus. Used in ants as a pumping organ.

pruinose, with the effect of a frosted or bloomlike covering.

psammophore, beard; referring to the long hairs beneath the head which are arranged in somewhat of a comblike series.

pubesecnce, the short, usually fine, appressed hairs covering the body and appendages.

pygidium, the dorsal surface of the last exposed gastric segment. The term is applied specifically to this region in the ants of the subfamily Cerapachyinae.

queen, see female ant. (For more detailed explanation see page 522 of the introduction.)

reniform, kidney-shaped.

replete, an inactive worker ant into whose greatly distended gaster food (honeydew) is stored for common use in the future. The food is later distributed among the workers through a process of regurgitation.

rugulae, small wrinkles.

rugulose, minutely wrinkled.

scalelike, a term applied to the petiole or postpetiole when the node is of a shape in distinct contrast to that of "nodiform." A term also applied to hairs when they have a general similarity to the scales on Lepidoptera.

scrobe, a groove formed for the reception or concealment of all, or part of an appendage.

sigmoid, shaped like the Roman S or the final lower case of the Greek sigma.

soldier, a worker ant which is distinct from other workers of its species by its larger size, much developed head or other structural characters; a major worker. (Also see page 522 of introduction.)

spatulate, spoon-shaped.

spine, an unarticulate thornlike outgrowth of the body wall.

sting, the spinelike organ borne near the apex of the gaster which is used as an organ of offense or defense. It is capable of being extruded or retracted. The sting is absent or vestigial in the subfamilies Dolichoderinae and Formicinae.

subcampanulate, somewhat bell-shaped.

subcordate, approaching the shape of a heart.

subopaque, nearly opaque but with a faint luster.

sulcus, a furrow or groove.

superior border of mandible, the border lying nearest to the clypeus.

tibial spur, the spinelike appendage borne near the apex of the tibia; a tibia may have one spur, two spurs or none.

turriform, tower form.

References to the Literature on the Ants of Various States

Arizona.

1. COLE, A. C., JR. 1937—An Annotated List of the Ants of Arizona. Ent. News **48**:97-101, 134-140.
2. WHEELER, W. M. 1906—The Ants of the Grand Canyon. Amer. Mus. Nat. Hist. Bul. **22**:329-345.
3. ———1908—The Ants of Texas, New Mexico and Arizona. Ibid. **24**:399-484, illus.
4. ———1911—Two Fungus Growing Ants from Arizona. Psyche **18**:93-101, illus.
5. ———1916—Two New Ants from Texas and Arizona. New England Zool. Club Proc. **6**:29-35, illus.
6. ———1917—The Mountain Ants of Western North America. Amer. Acad. Arts and Sci. Proc. **52**:457-569.

California. (Also see No. 6.)

7. ANDREWS, H. 1916—California Ants. Ent. News **27**:421-423.
8. ECKERT, J. E., AND MALLIS, A. 1937—Ants and Their Control in California. Calif. Agr. Expt. Sta. Circ. 342, 37 pp., illus., keys.
9. GREEN, H. E. 1931—Preliminary Study of the Ants of Southern California. Pomona Col. Ent. and Zool. Jour. **23**:25.
10. HILTON, W. A. 1919—Ants from the Claremont Laguna Region. Ibid. **1**:38.
11. LEONARD, P. 1911—The Honey Ants of Point Loma, California. San Diego Soc. Nat. Hist. Trans. **1**:85-113.
12. MALLIS, A. 1941—A List of the Ants of California, With Notes on Their Habits and Distribution. So. Calif. Acad. Sci. Bul. **40**:61-96, illus., keys.
13. MANN, W. M. 1911—Notes on the Guests of Some California Ants. Psyche **18**: 27-31.
14. PIJOAN, M. 1928—Formicidae of Southern California. Pomona Col. Ent. and Zool. Jour. **20**:37-42, illus.
15. WHEELER, W. M. 1904—Ants from Catalina Island, California. Amer. Mus. Nat. Hist. Bul. **20**:269-271.
16. WOODWORTH, C. W. 1910—The Control of the Argentine Ant. Calif. Agr. Expt. Sta. Bul. 207, 29 pp., illus.

Colorado. (Also see No. 6.)

17. ROBBINS, W. W. 1910—An Introduction to the Study of the Ants of Northern Colorado. Univ. Colo. Studies **7**:215-222, illus., keys.
18. WHEELER, W. M. 1904—Three New Genera of Inquiline Ants from Utah and Colorado. Amer. Mus. Nat. Hist. Bul. **20**:1-17, illus.

Connecticut. (Also see No. 6.)

19. WHEELER, W. M. 1906—List of the Formicidae. Fauna of New England. Boston Soc. Nat. Hist. Occas. Papers **7**:1-24.

20. ———1916—Formicidae. Hymenoptera of Connecticut. Conn. State Geol. and Nat. Hist. Survey Bul. **22**:577-601.

Florida.

21. SMITH, M. R. 1930—A List of Florida Ants. Fla. Ent. **14**:1-7.
22. ———1933—Additional Species of Florida Ants, With Remarks. Ibid. **17**:21-26.
23. ———1944—Additional Ants Recorded from Florida, With Descriptions of Two New Subspecies. Ibid. **27**:14-17.
24. WHEELER, W. M. 1932—A List of the Ants of Florida With Descriptions of New Forms. N. Y. Ent. Soc. Jour. **40**:1-17.

Georgia.

25. WHEELER, W. M. 1913—Ants Collected in Georgia by Dr. J. C. Bradley and Mr. W. T. Davis. Psyche **20**:112-117.

Idaho. (Also see No. 6.)

26. COLE, A. C., JR., 1933—Ant Communities of a Section of the Sagebrush Semi-desert in Idaho. Ent. News **44**:16-19.
27. ———1934—An Annotated List of the Ants of the Snake River Plains, Idaho. Psyche **41**:221-227.
28. ———1936—An Annotated List of the Ants of Idaho. Canad. Ent. **68**:34-39.

Illinois. (Also see No. 6.)

29. GREGG, R. E. 1944—The Ants of the Chicago Region. Ent. Soc. Amer. Ann. **37**:447-480, illus., keys.
30. TALBOT, M. 1934—Distribution of Ant Species in the Chicago Region, With Reference to Ecological Factors and Physiological Toleration. Ecology **15**:416-439.
31. TANQUARY, M. C. 1911—A Preliminary List of Ants of Illinois. Ill. Acad. Sci. Trans. **4**:137-142.

Indiana. (Also see Nos. 6, 29, 30.)

32. MORRIS, R. L. 1943—An Annotated List of the Ants of Indiana. Ind. Acad. Sci. Proc. **52**:203-224.
33. WHEELER, W. M. 1916—A List of Indiana Ants. Ibid. **26**:460-466.

Iowa.

34. BUREN, W. F. 1941—A Preliminary List of Iowa Ants. Iowa State Col. Jour. Sci. **15**:111-117.
35. ———1942—New Ants from Minnesota, Iowa and Wisconsin. Ibid. **16**:399-408.
36. ———1944—A List of Iowa Ants. Ibid. **18**:277-312, keys.

Kansas.

37. HAYES, W. P. 1925—A Preliminary List of the Ants of Kansas. Ent. News **36**:10-12, 39-43, 69-73.

Maine. (Also see Nos. 6, 19.)

38. PROCTOR, W. 1938—Formicidae. Mount Desert Region Survey, pp. 433-435. Publ. by Wistar Inst. of Anat. and Biol., Phila.
39. WHEELER, W. M. 1908—The Ants of Casco Bay, Maine, With Observations on Two Races of Formica sanguinea Latreille. Amer. Mus. Nat. Hist. Bul. **24**:619-645.

40. WING, M. W. 1939—An Annotated List of the Ants of Maine. Ent. News **50**: 161-165.

Massachusetts. (Also see Nos. 6, 19.)

41. STURTEVANT, A. H. 1925—Notes on the Ant Fauna of Oak Galls in the Woods Hole Region. Psyche **32**:313-314.

42. ———1931—Ants Collected on Cape Cod, Massachusetts. Ibid. **38**:73-79.

43. WHEELER, W. M. 1926—Formicidae. *In* Coker, R. E., Fauna of Penikese Island, 1923. Biol. Bul. **50**:35.

44. ———1928—Ants of Nantucket Island, Massachusetts. Psyche **35**:10-11.

Michigan. (Also see Nos. 6, 29, 30.)

45. GAIGE, F. M. 1914—The Formicidae of Charity Island. Result of the Mershon Expedition to the Charity Islands, Lake Huron. Mich. Univ. Mus. Zool. Occas. Papers No. 5, pp. 1-29.

46. ———1916—The Formicidae of the Shiras Expedition to Whitefish Point, Michigan, in 1914. Ibid. No. **25**, pp. 1-4.

47. WHEELER, W. M. 1908—The Ants of Isle Royale, Michigan. Ecology of Isle Royale. Mich. Geol. Survey Rpt., pp. 325-328.

Minnesota. (See No. 35.)

Mississippi.

48. SMITH, M. R. 1924—An Annotated List of the Ants of Mississippi. Ent. News **35**:47-54, 77-85, 121-127.

49. ———1927—An Additional Annotated List of Ants of Mississippi, with a Description of a New Species of *Pheidole*. Ibid. **38**:308-314.

50. ———1928—An Additional Annotated List of the Ants of Mississippi. Ibid. **39**: 242-246, 275-279.

51. ———1931—An Additional Annotated List of the Ants of Mississippi. Ibid. **42**: 16-24.

52. ———1932—An Additional Annotated List of the Ants of Mississippi. Ibid. **43**: 157-160.

Missouri.

53. RAU, P. 1934—Notes on the Behaviour of Certain Ants of St. Louis County, Missouri. Acad. Sci. St. Louis, Trans., pp. 207-215.

Montana. (See No. 6.)

New Hampshire. (Also see Nos. 6, 19.)

54. WHEELER, W. M. 1905—Ants from the Summit of Mount Washington. Psyche **12**:111-114.

New Jersey.

55. SMITH, J. B. 1909—Formicidae. N. J. State Mus. Ann. Rpt., pp. 655-663, illus.

56. WHEELER, W. M. 1905—An Annotated List of the Ants of New Jersey. Amer. Mus. Nat. Hist. Bul. **21**:371-403, illus.

New Mexico. (See Nos. 3, 6, 9.)

New York. (Also see No. 6.)

57. BEQUAERT, J. 1928—Formicidae. *In* Leonard, M. D., A List of Insects of New York, N. Y. (Cornell) Agr. Expt. Sta. Mem. **101**:995-1000.

58. DAVIS, W. T., AND BEQUAERT, J. 1922—An Annotated List of the Ants of Staten Island and Long Island, New York. Brooklyn Ent. Soc. Bul. **17**:1-25.

Nevada. (See No. 6.)

North Carolina. (Also see No. 6.)

59. BRIMLEY, C. S. 1938—Formicidae. Insects of North Carolina, pp. 425-430. Publ. by N. C. Dept. Agr. Div. Ent.

60. ———1942—Formicidae, p. 34. Ibid., supplement.

61. WHEELER, W. M. 1904—The Ants of North Carolina. Amer. Mus. Nat. Hist. Bul. **20**:299-306.

Ohio.

62. AMSTUTZ, M. E. 1943—The Ants of the Kildeer Plain Area of Ohio. Ohio Jour. Sci. **43**:165-173.

63. HEADLEY, A. E. 1943—The Ants of Ashtabula County, Ohio. Ibid. **43**:22-31.

64. KENNEDY, C. H. AND SCHRAMM, M. 1933—A New *Strumigenys*, with Notes on Ohio Species. Ent. Soc. Amer. Ann. **26**:95-104, illus.

65. WESSON, L. G., AND WESSON, R. G. 1940—A Collection of Ants from South Central Ohio. Amer. Midl. Nat. **24**:89-103.

Oklahoma. (Also see No. 6.)

66. SMITH, M. R. 1935—A List of the Ants of Oklahoma. Ent. News **46**:235-241, 261-264.

Oregon. (See No. 6.)

Rhode Island. (See No. 19).

South Carolina.

67. SMITH, M. R. 1918—A Key to the known Species of South Carolina Ants, with Notes. Ent News **29**:17-29, keys.

68. ———1934—A List of the Ants of South Carolina. N. Y. Ent. Soc. Jour. **42**: 353-361.

South Dakota. (Also see No. 6.)

69. SEVERIN, H. C. 1925—The Ants of South Dakota, with Key to Subfamilies of Worker Ants. S. Dak. State Ent. Ann. Rept., pp. 21-25, keys.

Tennessee.

70. COLE, A. C., JR. 1940— A Guide to the Ants of the Great Smoky Mountains National Park, Tennessee. Amer. Midl. Nat. **24**:1-88, illus., keys.

71. DENNIS, C. A. 1938—The Distribution of Ant Species in Tennessee with Reference to Ecological Factors. Ent. Soc. Amer. Ann. **31**:267-308, map.

Texas. (Also see Nos. 3, 5, 6.)

72. MITCHELL, J. D., AND PIERCE, W. D. 1912—The Ants of Victoria County, Texas. Ent. Soc. Wash. Proc. **14**:67-76.

73. SMITH, M. R. 1936—A List of the Ants of Texas. N. Y. Ent. Soc. Jour. **44**: 155-170.

74. WHEELER, W. M. 1900—A Study of Some Texan Ponerinae. Biol. Bul. **2**:1-31, illus.

75. ———1900—The Female of *Eciton sumichrasti* Norton, with Some Notes on the Habits of Texas Ecitons. Amer. Nat. **34**:563-574, illus.

76. ——— AND LONG, W. H. 1901—The Males of Some Texas Ecitons. Ibid. **35**: 157-173.

77. ———1902—New Agricultural Ants from Texas. Psyche **9**:387-393, keys.

78. ———1903—A Decade of Texan Formicidae. Ibid. **10**:93-111, illus.

79. ———1911—Descriptions of Some New Fungus Growing Ants from Texas with C. G. Hartmann's Observations on Their Habits. N. Y. Ent. Soc. Jour. **19**:245-255, illus., keys.

Utah. (Also see Nos. 6, 18.)

80. COLE, A. C., JR. 1942—The Ants of Utah. Amer. Midl. Nat. **28**:358-388, illus., keys.

81. REES, DON M., AND GRUNDMANN, A. W. 1940—A Preliminary List of the Ants of Utah. Utah Univ. Bul. **31**:1-11.

Vermont. (See No. 19.)

Washington. (Also see No. 6.)

82. SMITH, F. 1941—A List of the Ants of Washington State. Pan-Pacific Ent. **17**: 23-28.

Wisconsin. (Also see Nos. 6, 29, 30, 35.)

83. BURRILL, A. C. 1918—A Preliminary List of the Ants of Wisconsin. Ohio Jour. Sci. **18**:229-232.

84. ——— AND SMITH, M. R. 1919—A Key to the Species of Wisconsin Ants, with Notes on Their Habits. Ibid. **19**:279-282.

Wyoming. (See No. 6.)

Index

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
AGRICULTURAL RESEARCH ADMINISTRATION,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

Homology and Analogy

A Critical Review of the Meanings and Implications of these Concepts in Biology

Alan Boyden*

Introduction

The biological concepts of homology and analogy have been discussed in recent years by several authors, among them being De Beer (1928, 1938), Huxley (1928), Wright (1934), Boyden (1935, 1943), Hubbs (1944), Moment (1945), and Haas and Simpson (1946). Morphology's "central conception" is once more receiving the consideration which its importance deserves. The views presented by these authors are, as could be expected, somewhat divergent and the attention of biologists has therefore been called to "the need for the best possible appraisal," (Hubbs, 1944). The recent account of Haas and Simpson is most critical and scholarly but it is still possible to present and support another point of view with regard to the use of homology which does not place upon that concept the exacting specification of *proof* of common origin. The very nature of the data so often makes the satisfaction of that prerequisite impossible. The present account is an attempt to sketch the minimum considerations preliminary to gaining that "best possible appraisal" desired by all of us.

The need for a reexamination of these terms will be evident from a glance at the list of meanings of homology which follows immediately and the similar list of analogy shown later.

Some Meanings of Homology

1. An essential structural similarity. — Owen (1843, 1847).

2. An essential structural similarity due to common ancestry. — Darwin (1859), Haeckel (1866), Gegenbaur (1878).

3. The relation between any antigen and the antiserum produced in response to it. — Kraus (1897) and serologists generally.

---

* The writer has availed himself of every opportunity over a period of many years to discuss these and other basic concepts in the field of systematic zoology and to correspond with others regarding them. I may mention specifically only those who, whether they approve in principle of the views set forth or not, have been most helpful in their development. These are C. M. Breder, Jr., C. L. Fenton, T. C. Nelson, W. L. Schmitt, G. H. Shull, G. G. Simpson, and L. A. Stauber. Thanks are due to W. L. Schmitt and C. R. Shoemaker, of the U. S. National Museum for the specimens used in figures 1 to 6, to C. R. Shoemaker and Zoologica for permission to reproduce parts of these figures, and to Sewall Wright and the Biological Laboratory at Cold Spring Harbor for permission to prepare figure 7 as a modification of the figure shown in Wright (1934). To all these and to the many others who have given time and thought to the clarification of their own views I express my sincere appreciation.

4. The relationship between chromosomes which pair during maturation or which are descended from the same original chromosomes. — Cytologists and geneticists.

5. The relation among genes acting as alleles, or between corresponding loci on similar chromosomes. — Geneticists.

6. Series of parallel mutations or varieties in related species. — Vavilov (1922).

7. Any structural similarity due to common ancestry. — DeBeer (1928), Shull (1929).

8. Any similarity, whether structural or functional, which is of common evolutionary derivation. — Hubbs (1944).

9. Any tissues in an organism stimulated by the sex hormones characteristic of that sex, and inhibited by the sex hormones of the opposite sex. Does not refer to the anatomical correspondence of any parts of the reproductive systems of either or both sexes. — Moore (1944).

An Examination of the Implications of Homology

In the varied definitions of homology just listed, there are only two main ideas: (1) The idea of essential similarity, (2) the idea of common ancestry. The original concept of homology as it came into general use in biology at the beginning of the 19th century was *essential structural similarity*, and it was not till the post-Darwinian period arrived that the term homology came to imply *common ancestry*. Today the pendulum has swung so far from the original implication in homology that some recommend that we define homology as any similarity due to common ancestry, as though we could know the ancestry independently of the analysis of similarities! Let us have a more critical view of the history of homology to see if this history is natural or unnatural.

The implications in homology in its original biological sense of essential structural similarity are chiefly these: (1) that the biologists *can* recognize "essential" structural similarities in the organisms which they compare, and (2) that it is important that they be able to do this.

For the first relatively clear statements giving the specifications for essential structural similarity and descriptions of the kinds of homology we must turn to Owen. In his report "On the Archetype and Homologies of the Vertebrate Skeleton" Owen (1848) describes three kinds of homology as follows:

1. *General Homology* — the structural resemblance of some particular part or organ or organisms to the figurative or conceptual type (archetype) of such parts or organisms.

2. *Serial Homology or homotypy* — the structural correspondence of the parts arranged along the axes of the body of one organism.

3. *Special homology* — the structural agreement of corresponding parts of the bodies of different organisms.

Of these three kinds of homology we need not at this time discuss the general homology, which was a relatively abstract concept as Owen used it, but let us examine the criteria for the recognition of serial and special homologies as set forth in Owen's words: —

"These relationships (that is, homologies) are mainly, if not wholly, determined by the relative position and connection of the parts, and may exist independently of form, proportion, substance, function and similarity of development. But the connections must be sought for at every period of development, and the changes of relative position, if any, during growth must be compared with the connections which the part presents in the classes where vegetative repetition is greatest and adaptive modification least.

"There exists doubtless a close general resemblance in the mode of development of homologous parts; but this is subject to modification, like the forms, proportions, functions and very substance of such parts, without their essential homological relationships being thereby obliterated." (Owen 1848, p. 6)

The criteria for the recognition of homology used by Owen were therefore: —

1. Similarity in the relative position and connections of corresponding parts (following Geoffroy Saint-Hilaire 1818).

2. Similarity in the adult structural organization of those parts.

3. Similarity in the development of those parts.

These criteria were applicable to organisms whose ancestry was *honestly* admitted to be unknown and furthermore *the uses to which such parts were put were of no importance in the determination of their homologies or non-homologies.*

It has been claimed by some recent authors that serial and special homology are essentially similar phenomena and that resemblances in serial homology "surely have the same sort of evolutionary significance that other types of homology furnish" (Hubbs 1944). "Bateson and Hubbs have both demonstrated, the distinction between special, serial, and general homology is not a valid one" (Moment 1945). Bateson and Hubbs neither have nor can demonstrate any such thing. Serial homologues are, by definition, intraindividual correspondences and have therefore no direct bearing upon problems of systematic or genetic relationship or evolutionary ancestry. It is, on the contrary, only special homologies, i.e., structural correspondences between different organisms whose resemblances and differences have any direct bearing upon problems of taxonomy and the analysis of racial descent. Consequently we shall need to examine the prerequisites for the conditions of serial and special homology separately.

1. Prerequisites for serial homology.

The chief requirements needed to establish the condition of serial homology are these:

a. The corresponding parts are intraindividual and arranged in some kind of series.

b. The parts should agree in relative position and connections and in adult structure and development.

Now these requirements may be made relatively objective. Thus one need first establish that the parts being compared belong to a single organism; a task that in most cases can be definitely accomplished. Secondly, the parts must be found to agree in their relative positions and connections in corresponding metameres or segments of the body as in a lobster or crayfish and to have the same essential structural organization and embryonic development. Thus all the jointed appendages of a lobster agree in their relative positions in successive metameres and in their mode of development. Furthermore as adult structures they all agree in being paired, jointed, encased in chitin secreted by a hypodermis, with internal striated muscles, and with blood sinuses. Because of these essential structural agreements no competent zoologist would ever mistake an arthropod appendage for any other kind of jointed or unjointed appendage. But this essential agreement which establishes the condition of serial homology or homotypy does not require identity. Thus these appendages may vary even in the number of their principal parts and in the number of joints and segments in each. Some members of a group of serial homologues may be biramous, some may be uniramous; some may be chelate, others not. The relative proportions of the parts may vary widely and all without denying the essential homological relationship of these parts.

Serial homology has thus far been presented as a purely morphological concept as it was rightly considered to be by Owen. Since Darwin, however, we have tended to become a cult of ancestor worshippers and have come so far in this direction that we have misled ourselves and our students into a morass of confused ideas, such as to imply that serial homologues can only be recognized on the basis of ancestral criteria.

As an illustration of this situation let us examine the question of the serial homology of antennae and antennules and also the compound eyes in Crustacea with special reference to the ancestral criterion of homology.

The moot questions are these:

1. Are the first and second pairs of antennae serially homologous with each other?

2. Are the first or second antennae or both, serially homologous with mouth parts or walking legs?

3. Are the compound eyes serially homologous with any other appendages?

A brief review of the literature shows a divergence of opinion regarding these questions. Huxley (1880) stated that the first and second antennae were built upon the same plan of organization and therefore interpreted the antennae as serially homologous with each other and with the remaining jointed appendages, as the following brief quotation clearly reveals: (Huxley, 1880)

"From this brief statement of the characters of the appendages, it is clear that, in whatever sense it is allowable to say that the appendages of the abdomen are constructed upon one plan, which is modified in execution by the excess of development of one part over another, or by the suppression of parts, or by the coalescence of one part with another, it is allowable to say that all the appendages are constructed on the same plan, and are modified on similar principles."

Similar views were held by Brooks and Herrick (1891), by Herrick (1895), and by Bell (1905). On the other hand Calman (1909) speaks of there being considerable doubt as to the amount of agreement in the first and second antennae, and as to whether the two flagella of the first antennae represent endopod and exopod. Snodgrass (1935) describes the first antennae of Crustacea as "never biramous in the manner characteristic of the second antennae and the succeeding appendages." Borradaile and Potts (1936) write as follows: "Of the *appendages* or *limbs* of the Crustacea, the first, or antennule, is a structure *sui generis*, not comparable in detail with any of the others. Typically it is uniramous, and though in many of the Malacostraca it has two rami, these are probably not homologous with the rami, described below, of other appendages." Gurney (1942) speaks of the antennules as being, "true preoral appendages and, as such, not built upon the same plan as the others."

Figs. 1-6 represent in a slightly diagrammatic manner, the resemblances and differences between the first and second antennae of two species of Amphipoda, viz., *Thoriella islandica* Stephen, and *Crangonyx shoemakeri* Hubricht and Mackin; and of one species of Isopoda, *Colidotea rostrata* Benedict. These appendages are strikingly similar in essentials, varying mainly in the degree of development of a single pattern, and resembling each other far more than the second antennae resemble mandibles, pereiopods or other crustacean appendages. Curiously, the serial homology of the second antennae with the other jointed appendages except the first antennae seems never to be doubted, while the serial homology of first and second antennae is currently denied by many.

For the Crustacea as a whole the facts relating to the serial homology of crustacean appendages are presented in the summary which follows.

Summary of facts bearing on the serial homology of the antennae and other jointed appendages of Crustacea.

1. All the jointed appendages are so essentially similar in respect to their fundamental construction that no competent morphologist would ever confuse an arthropod appendage with any other kind of jointed appendage or any kind of non-jointed appendage.

2. The crustacean limb is typically biramous, that is, it possesses a single stem and two branches.

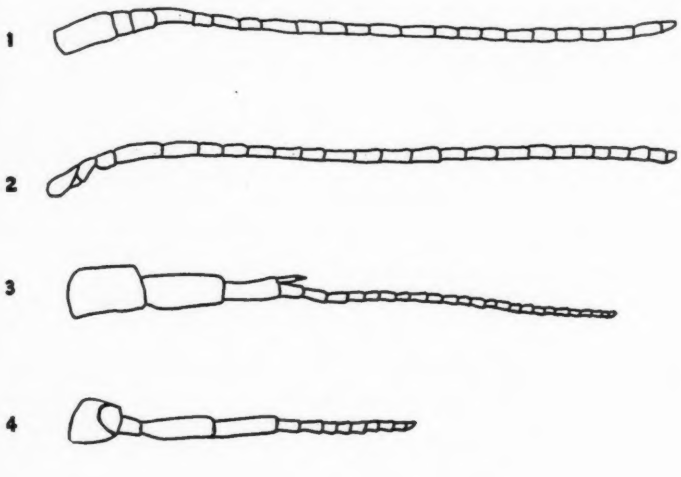
3. The degree of development of these limbs from antennules to uropods is variable, as are the adult sizes and proportions of their various parts.

4. Any limb may be uniramous instead of biramous, in the adult stage or throughout life.

5. The first and second antennae agree in being typically filiform.

6. The first antennae are usually uniramous in early stages of development at a time when the second antennae may be biramous.

7. The number of well-developed segments in the basal stem (protopod) of the first antennae is often three whereas the number of well-developed seg-



Figs. 1-6. Drawings, somewhat diagrammatic, of the first and second antennae of three species of Crustacea. Hairs omitted, appendages straightened. — 1 and 2. First and second antennae of *Thoriella islandica* Stephen (Amphipoda) redrawn from Shoemaker (1945) with permission of author and editor. Side view about 8×. — 3 and 4. First and second antennae of *Crangonyx shoemakeri* Hubricht and Mackin (Amphipoda). Dorsal view, about 15×. — 5 and 6. First and second antennae of *Colidotea rostrata* Benedict (Isopoda). Dorsal view, about 15×.

ments in the stem of the second antennae is often two, but the number of segments in the principal parts of the crustacean limb (protopod, exopod and endopod) is variable among Crustacea.

8. The first antennae are preoral in position whereas the second antennae generally arise from buds at the level of the mouth, to move relatively forward in later stages.

9. The first antennae are innervated from a more anterior part of the central nervous system than are the second antennae.

The summary shows that there is no kind of consistent difference between the antennules and any other of the jointed appendages or limbs of Crustacea except the antennules come in front of the antennae, and are innervated from a different part of the nervous system.

If we claim that the first antennae are "really" uniramous because they are so in the nauplius at a time when the second antennae are biramous then we should have to deny likewise the serial homology of some pereiopods with others, for some are never biramous at any stage of development and others characteristically are. If the point is made that the flagella of the first antennae cannot be considered endopod and exopod because there are three well-developed segments in the protopod of the first antennae and only two in the protopod of the second antennae, we could be mistaken because the number of segments in all parts of these appendages is variable. Furthermore, where a precoxa can be distinguished the protopod of the pereiopods is three-segmented and hence the occurrence of three segments in the protopod of the first antennae is no strange condition among Crustacean appendages. If we take Gurney's position and state that the first antennae, *being preoral,* are *therefore* not built upon the same structural plan as the second antennae, we must do so on the basis of some preconceived notion that a preoral appendage cannot be essentially similar to the postoral appendages of the same animal, a notion that is more easily reached with our eyes shut for only then may we ignore the obvious essential structural agreements in antennae and antennules and between both of them and the remaining jointed appendages.

In the absence of any consistent essential structural difference between first and second antennae, we should therefore admit their serial homology and put them both in the same category as the remaining jointed appendages, all being serial homologues constructed and developed on the same ground plan.

There is some misconception existing among crustacean systematists according to which the ancestral criteria of homology may be considered decisive in regard to the recognition of serial homologues. The assumption is, that if antennules and antennae have had a different phylogenetic history, they may not be considered to be serially homologous in the descendants, no matter how similar structurally they may become. Thus, assuming that the antennules of Crustacea were derived by evolutionary processes from the palps of Annelida, whereas the antennae were derived from more posterior appendages, it is

held that this is sufficient to "veto" (Snodgrass) the serial homology of antennules and antennae of modern Crustacea.

I do not admit the validity of this "veto power" on these grounds:

(1) Serial homologues are by definition *intraindividual* parts which are essentially similar in structure and relative position. The question of serial homology in an annelid or in a crustacean is a matter of intraindividual comparisons and can only be determined from the structures available in each. Whether the palps and parapodia of an annelid are serially homologous or not must be judged from the amounts and kinds of similarity those parts of one individual show, and whatever the conclusion may be for the annelid, it has no bearing whatever upon the determination of the serial homologues within the body of a crayfish. The facts of morphology must not be denied on the basis of extraneous and hypothetical assumptions regarding ancestry — to continue to do this is to convert morphology into a pseudoscience.

(2) In the recognition of any kind of homology, the primary facts are the amounts and kinds of structural resemblance. Ancestry is inferred from special homologies not serial homologies and must of necessity be more obscure than the facts of animal organization upon which the conclusions regarding ancestry are based. To place inferences regarding ancestry in a position of decisiveness over structural comparisons is a blunder even where special homologies are concerned; in the case of serial homologies it shows a complete misconception of the nature of the phenomena of serial homology.

But what should be said regarding the compound eyes? Using the same kind of prerequisites as before, i.e., essential agreement in structure and development and in relative position and connections, we cannot accept the serial homology of eyes with any other appendages. For the eyes develop differently and are different in their essential parts from all other appendages. Nor does the fact that an antenna-like structure may sometimes regenerate at the site of the compound eye prove the serial homology of these two appendages, for the regenerated antenna is no more eye-like than the normal one and therefore simply cannot meet the minimum requirements for serial homology. The fact that such heteromorphic regeneration does occur is interesting and indicates the relatively great potentiality of the cells lying at the base of the eye but we have known of similar embryologic facts for a long time and still an eye is an eye and nothing else.

2. Prerequisites for the condition of special homology.

As we have already indicated, the original concept in homology was essential structural similarity. This concept, applied to the corresponding parts of the bodies of different organisms, was the basis for the classifications of Owen, Huxley and many other naturalists. As knowledge of corresponding structures in animal types increased, mistakes made because of imperfect knowledge of structure were corrected and more natural groupings of animals were attained. Barnacles, king-crabs and many other organisms misplaced in classification could now be assigned to places among their peers. The only assump-

tions necessary in this procedure were these: (a) animals can and should be classified according to their essential structural organization; (b) naturalists can recognize essential structural agreements when they see them.

Then came Darwin. The clue to such essential structural similarities as could be determined was now believed to be heredity operating through common ancestry. As naturalists accepted more and more the evolutionary interpretation of all animal organization they put greater and greater stress upon ancestry and for some time now the chief goal of taxonomy has been commonly stated to be the "expression of phylogenetic relationships." So far has the pendulum apparently swung from a classification originally based on essential structural similarity to one *allegedly* based on ancestry that now homology is defined as *any* similarity due to common ancestry! *As though we could know the ancestry without the essential similarities to guide us!* It is time that we had a clearer view of the real implications and limitations of these concepts.

In the first place it is a bit startling to realize that the labors of systematists in the 19th century *before* and *after* Darwin produced essentially similar fruits, i.e., the classifications of Owen and of Huxley show no marked differences from those which followed except insofar as greater knowledge of comparative anatomy made it possible to group animals more naturally. This fact alone should make us cautious about breaking completely with the old concepts of homology and systematics. Then on further examination, we find that the criteria for the recognition of special homology are *really the same as before,* viz., those oft-mentioned qualities of essential similarity in relative position and connections and in the structure and development of the corresponding parts of the bodies of different organisms. Let us therefore critically examine the concept of special homology (a) as essential similarity, (b) as due to common ancestry.

a. Special homology as *essential similarity.*

The prerequisites for the condition of special homology are as follows:

(i) The structural correspondence must be interindividual.

(ii) There should be agreement in relative position and connections.

(iii) There should be agreement in adult structure or development or both.

Good illustrations of special homologues, i.e., "the same organ in different animals under every variety of form and function" (Owen 1843) may also be found in Crustacea. Thus the chelipeds of crayfish, lobster and crab are all essentially similar in their relative position and connections, and in their adult structure and embryonic development. But essential similarity does not require identity. Thus throughout the Crustacea we find many modifications of the general plan of appendage. For example, in decapod Crustacea the first pair of appendages following the maxillipeds is often, but not invariably, chelate. The southern lobster (*Panulirus argus*) has special homologues of the chelipeds of the northern lobster but these appendages are non-chelate in the southern, and chelate in the northern lobster. This is no essential morphologi-

cal difference, however, for all that is needed to make a chelate appendage is the capacity of a projection of the propod to oppose the dactylopod. The *maximum* difference between a chelate and non-chelate appendage is the presence or absence of a prolongation or knob on the propod together with the necessary neuromotor apparatus to make it work. Besides such differences special homologues may vary in the number of their principal parts; in the number of segments in each; in their sizes and proportions; and all this without invalidating their essential homological relationship. So far, the recognition of special homologues has been a purely morphological concern, deepndent on no theory of ancestry. What now of the criterion of common evolutionary origin for special homology?

b. Special homology as *"due to common ancestry."*

As has been said, current definitions of homology almost unanimously stress common ancestry as a prerequisite and may even go so far as to state that "the sole condition which organs must fulfill to be homologous is to be descended from one and the same representative in a common ancestor" (De Beer 1928).[1] This definition implies (1) that common evolutionary ancestry can be known without knowledge of essential similarity, (2) that organs actually descend from ancestral organs, and (3) that it is more important in taxonomy to know the ancestry than the amount of essential similarity. Since each of these implications is doubtful, let us examine them in turn.

In the first place, we cannot learn of the probable ancestry of existing or pre-existing species or individuals, lacking pedigree records, without the demonstration of some kinds of conservative hereditary traits. In the present discussion we are concerned mainly with morphological comparisons and homologies. We infer ancestry from the amounts and kinds of essential structural agreements. As Gegenbaur (1878) said, "Blood relationship becomes dubious exactly in proportion as the proof of homologies is uncertain." In other words, if there is any doubt as to the essential nature of the structural correspondences between different organisms there must be at least as much doubt regarding their ancestry. One would be led to believe from the current definitions of homology, even if not the extreme one given by De Beer, that we first *know* the ancestry and then decide that the corresponding organs or parts may be called homologues!

How did this misorientation of our thinking arise? One of the earliest steps was taken by Lankester (1870), who proposed new terms to be used in morphological comparisons. Thus the term *homogenous* was to be applied to structures which are genetically related "insofar as they have a single representative in a common ancestor." This usage leads us to the consideration of the second of the false implications in De Beer's statement, i.e., that organs or parts actu-

1 De Beer (1938) discusses homology at a far higher level of understanding than displayed in his statement of 1928, and on the basis of embryological and genetic considerations concludes, "that the best criterion for homology is comparative anatomy. . . ." (p. 70). But it is, unfortunately, the 1928 De Beer who typifies prevalent opinion regarding homology, which opinion is being critically examined.

ally descend from ancestral organs or parts or may have "a single representative in a common ancestor."

Today it is well known that organs or parts do not generally descend from similar pre-existing organs or parts even by means of asexual reproduction. But the capacity to develop essentially similar organs or parts may be conservatively inherited for long periods and through many generations. Only in this sense may we speak of tracing an organ to a single representative organ in an ancestral individual. When we do this we do it by *structural gradation*, by essential structural similarities only! Even with the fullest fossil representation there is no other way. Furthermore we can never be sure that we have traced an organ to a *single* representative in a common ancestral individual for there might readily have been collateral lines which possessed this organ, there could have been parallel mutations just preceding or following the first known somatic expression of this organ or part, and there could readily have been the simultaneous or successive expression of recessive characters in many individuals instead of in a single one. Obviously the prerequisite for *homogeny* as Lankester defined it are impossible of fulfillment *even with a full fossil representation!* In the more common case among the Invertebrata where the fossil representation may be scanty or inadequate the difficulties are insuperable. In many soft-bodied groups such as the phyla of ctenophores and worms and in soft parts of the bodies of animals generally we may have nothing but *existing* characters to compare, there may be actually no *known* ancestors and no *known* ancestral characters! No wonder the term homogeny has not been widely adopted, though its implication that we determine homology only by ancestry is widely prevalent in these times! Finally, we come to the third of the doubtful implications in De Beer's statement, an implication also present in our current definition of homology as similarity due to common ancestry, i.e., that it is more important to know the ancestry than the amount of similarity —granted that this were possible. The general falsity of this implication is indicated by these facts:

(1) For the great majority of animal types the fossil records are, and necessarily will be, inadequate for the purpose of *knowing* the ancestry.

(2) If we have had a monophyletic origin of animal protoplasm, as many zoologists appear to believe, then *all* similarities are as much "due to ancestry" as to any other known factors. This provides no basis for grouping animals according to their natures.

(3) As clearly stated by Bather (1927), even a genealogy provides no classification, for the grand object of classification is to put essentially like things together. In other words we must classify on the basis of essential natures, there is no other useful basis.

The current definitions of homology which state that organs or characters are homologous only when due to common ancestry are therefore not correctly stated or properly conceived on the following grounds:

(1) They relegate the original and most important basis for the recognition of homologies, i.e., *essential structural similarity*, to the background or ignore it entirely.

(2) They imply that knowledge of ancestry can be gained without recourse to the analysis of the amounts and kinds of essential similarities available.

(3) They imply that knowledge of ancestry is more important in taxonomy than the knowledge of structural agreements.

(4) They mislead students and teachers alike into the belief that the ancestry of the majority of animal groups is well known.

(5) They divert our attention from the main task before us, which is to classify on the basis of essential natures and to develop the most objective criteria and methods possible for this purpose, and they lead us into a quagmire of conflicting speculations regarding the probable and improbable ancestry of particular groups.

Let us get back to the main task of systematic zoology and attack its problems with freshness and freedom from the bias of too great dependence upon ancestry. In biology as in human life generally, we cannot depend on ancestry to solve our problems for us. There is a great task ahead which is to develop objective criteria for morphological comparisons, applicable to all the types of animals whether they are known only as existing types, only as fossils, or as both. Let us use homology as an honest term indicating essential structural similarities and not requiring proof of ancestry which, for even major groups of animals, we do not now possess and may never acquire. Even if it should prove impossible for the human mind to reach general agreement as to what constitutes "essential" similarity in the structural organization of animals of various types *then we need to know that and act accordingly.* We would then need to develop independent and more objective methods for the comparison of animals such as perhaps those methods which have a biochemical or serological foundation. But if we are obliged to give up our analysis of structural similarities because of the too great element of subjectivity contained in them, then *we must certainly give up those dreams about phylogeny which are even more subjective than the facts of animal organization upon which they are based!*

The Implications of Analogy for Biology

It is a difficult task to summarize the meanings of analogy to the biologist. The list of meanings shown below indicates that this word has not only been used to convey diametrically opposite conditions of character expression, i.e., an essential vs. a non-essential structural similarity, but many gradations of meaning between these extremes.

SOME MEANINGS OF ANALOGY IN BIOLOGY

1. An essential structural similarity. — Geoffroy Saint-Hilaire (1818).
2. A functional similarity especially in the use of parts. with or without essential structural similarity. — Owen (1843, 1847).
3. A superficial structural similarity. — Macleay (1825), Strickland (1846), Jacobshagen (1925), Nowikoff (1935).

4. A superficial structural similarity due to use. — Darwin (1859) and modern texts.

5. Parallel variations in related species. — Darwin (1859).

6. Any structural similarity not due directly to common ancestry. — Darwin (1859).

7. Functional or physiological agreements. — Haeckel (1866) Lankester (1870), Gegenbaur (1878).

8. A superficial similarity, structural or functional, not due to common ancestry. — Hubbs (1944).

9. A similarity in use of structures or functions which are of independent origin and history. — Hubbs (1944).

Actually, the term analogy is hopelessly ambiguous as currently used and should either be dropped entirely or relegated to some minor place in the terminology of structural and functional comparisons with a simple and clear statement of meaning. The specifications just mentioned fit Owen's meaning of analogy to indicate a similarity in the use of parts regardless of their other attributes. The term can be employed effectively in this way without detracting in the least from the effectiveness and clarity of the words homologous vs. non-homologous to imply essential structural similarities as distinguished from non-essential structural similarities. Physiological agreements of the nature of intrinsic functional mechanisms may prove to be of such importance as to warrant a new term to imply physiological correspondence or equivalency, instead of analogy since analogy is a word which can cover up almost any meaning.

Now if we follow Owen's meaning of analogy, we find that the term has some definite but commonly misunderstood implications for biology. The chief considerations in this situation are as follows: —

(1) Structures which are essentially similar, as well as structures which are essentially different, may serve the same use to the organisms and thus be *analogues*.

(2) Structures may retain essential similarity even though some are used and some are not.

(3) There is no conclusive evidence that use can modify the genetic constitution of any part or organ.

(4) A long period of similarity in the use of parts such as in the case of the wings of insects and birds has resulted in no more than a very superficial similarity in their structures.

All this causes us to conclude that a similarity in use (Owen's analogy) has very little to do with the essential structural expression of organic characters. We should be well advised therefore if we stop talking about similarities of any kind "due to use" and focus our attention on the primary data of taxon-

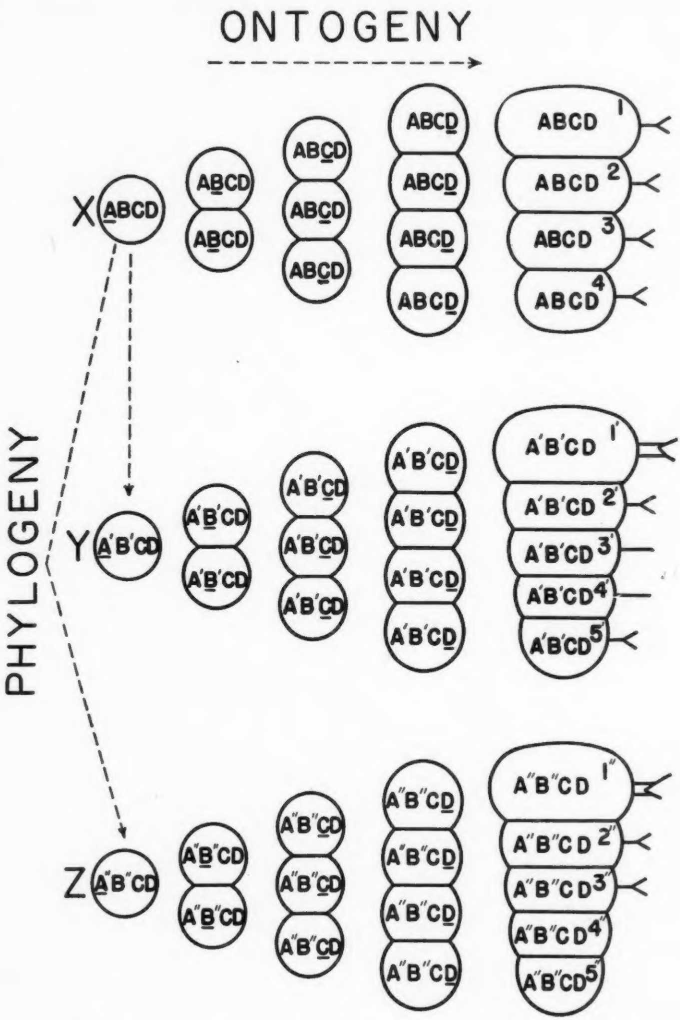


Fig. 7.—A diagram to show some of the relations of ontogeny and phylogeny to each other, in terms of the hereditary mechanisms responsible for each. Modified from Wright (1934) with permission of author and editor.

omy which are the amounts and kinds of essential structural and biochemical agreements.

The Mechanisms of Serial and Special Homology

Brief accounts of this *mechanism* have been given by Wright (1934), De Beer (1938) and by Boyden (1935, 1943). The illustrative figure of Wright is especially helpful and has been modified in order to include phylogenetic as well as ontogenetic structural expressions. The mechanism of homology is the mechanism of heredity in all its complications, and all the data of genetics, cytology and embryology are concerned in our understanding of this mechanism. Here we shall attempt only a brief sketch of the hereditary mechanisms especially in regard to the resemblances and differences in the mode of operation of the genetic mechanism of serial or intraindividual versus special or interindividual homologies.

A. The mechanism of resemblance in homologues.

(1) Serial homologues — the same genes interacting with the similar parts of the cytoplasm within the limits of one egg or asexual product, or one embryo or one adult organism.

(2) Special homologues — the same or similar genes interacting with the same or similar parts of the cytoplasms of more than one egg, asexual product, embryo or adult.

B. The mechanism of difference in homologues.

(1) Serial homologues — the same genes interacting with the somewhat different parts of the cytoplasm of one egg, asexual product, embryo or adult.

(2) Special homologues — different genes interacting with the same or different cyptoplasms of more than one egg, asexual product, embryo or adult.

Figure 7 is a diagram to show some of the relations of ontogeny and phylogeny to each other, in terms of the hereditary mechanisms responsible for each. Five developmental stages are shown, characteristic of the individuals representing the primitive type X, and two different derived types independently descended from X, viz., Y and Z. The letters A B C D and their primes, represent groups of genes which remain constant in each ontogeny, but have come to differ, in part, in the new types of descendants. The letters underlined represent groups of genes which come into action in the particular developmental stages in which they are found.

The diagram shows in a simple way the operation of the genetic mechanisms concerned in ontogeny and phylogeny. Note particularly that gene constitution stays the same during any ontogeny, but comes to differ during the succession of divergent ontogenies called phylogeny. Thus, in the case of the serial homologues within any single individual, both their resemblances and differences are a result of the interaction of the *same genes* in all cells with the various kinds of cytoplasm characteristic of that organism. But in the case of the special homologues illustrated by the corresponding appendages of the adult types X, Y, and Z, the resemblances are due to the same or similar

genes interacting with the same or similar cytoplasms of the diverse types compared, whereas the differences are due to different genes interacting with the same or different cytoplasms characteristic of these types.

Serial homologues, being intraindividual corresponding parts, are recognized as such on the basis of their essential similarities only. Special homologues, even though their differences are products of evolution and their resemblances are due to inheritance, are also recognized as such because of their essential structural characteristics. Lacking an actual pedigree, or an almost perfect fossil record, no one could tell whether X, Y, or Z was the more primitive type and thus be able to provide the correct interpretation of the phylogenetic events illustrated in the figure. Homology cannot by itself provide us with pedigree records. Assuming that X is the more primitive type, and that Y and Z are two independently evolved types derived from X, then the following processes are illustrated in figure 7:

1. Addition.
   a. of a metamere (5′; 5″).
   b. of an appendage (5′).
2. Loss.
   a. of an original appendage (4″).
3. Specialization of appendages.
   a. Increase in size and complexity (1 - 1′; 1 - 1″).
   b. Decrease in complexity (3 - 3′; 4 - 4′).
4. Parallel evolution.
   a. In addition of metameres (5′ and 5″).
   b. In specialization of parts (1 - 1′; 1 - 1″).
5. Divergence.
   a. In number of appendages (5 pairs in Y; 3 pairs in Z).
   b. In the nature of appendages.
      i change from biramous to uniramous (3 - 3′; 4 - 4′).
      ii loss (4 - 4″).

The sketch of these mechanisms shows some interesting and significant contrasts in their mode of operation, even though both deal with the interaction of nuclei and cytoplasms. First, the differences in serial homologues are not normally due to differences in genes which make up the genotype of their cells whereas differences in special homologues usually are due to just such differences. Second, the mechanism of differentiation in serial homologues is a part of the larger and more inclusive mechanism of embryologic differentiation which operates so as to produce rapidly, often within hours or days, not only differences in serial homologues but all the diverse types of structures which may arise out of a single egg, including many non-homologous structures. On the other hand, the mechanism of special homology is of such a nature as to conserve with remarkable fidelity over long periods of time

involving many successive generations, those essential similarities in structure and development as well as the even more conservative agreements in relative position and connections which are so characteristic of special homologues.

Thus an analysis of the mechanisms of serial and special homology reveals their true natures and fully justifies the attempt to distinguish between them in our thinking. Serial homology arises and is limited to ontogeny; special homology is directly concerned with taxonomy and phylogeny and clarity and effectiveness of thought demands that we distinguish between these phenomena in our thinking and writing.

The Relation of Homology and Analogy to Other Terms Needed in Systematic Zoology[2]

This may be approached from the point of view of the question; what are the essential kinds and natures of the character expressions of organisms? The chief alternatives are the following:

1. The expression of characters is due mainly to heredity or mainly to environment.

2. There is essential similarity in the structural expressions or there is not.

3. There is essential similarity in physiological characters (including behavior) or there is not.

4. The characters expressed have had common ancestry or they have not.

5. Knowledge of ancestry may make it possible to determine that the characters have (a) diverged, (b) run parallel, or (c) converged, in their expression.

6. Where knowledge of ancestry based on good fossil series is available it may be possible to determine whether the character expression is *primitive* or *specialized*.

The definitions correlated with the above kinds of character expression may be stated as follows:

1 (a) *Hereditary*. Due principally to the transmission from parent to offspring of organized protoplasm with its innate capacities.

(b) *Non-hereditary*. Not due principally to the transmission of organized protoplasm from parent to offspring with its innate capacities.

2 (a) *Homologous*. Essentially similar in the structure and embryonic devel-

[2] The scholarly and critical account of Haas and Simpson (1946) has just appeared. Some of the terms listed here are critically analyzed as to their historic connotation and most effective usage, together with many others not included in this list. The report of Haas and Simpson may be compared with the present account to note both resemblances and differences in specific recommendations and reach a decision as to the nature of the better solution of the difficulties.

opment and in the relative position and connections of corresponding parts of the bodies of organisms.

(b) *Non-homologous*. Lacking in the quality of essential structural similarity.

3 (a) *Physiological correspondence*. Fundamental similarity in intrinsic functional mechanisms and processes including behavioristic activities.

(b) *Physiological non-correspondence*. Lacking in the qualities species in 3 (a).

4 (a) *Monophyletic*. The characters (structural, functional or behavioristic) have had a single known evolutionary derivation.

(b) *Polyphyletic*. The characters have had more than one known evolutionary derivation.

5 (a) *Divergent*. The characters expressed in certain organisms differ more than do the corresponding characters of their ancestors.

(b) *Parallel*. The corresponding character expressions of two lines of ancestry present the same amounts of resemblance and difference for series of successive generations.

(c) *Convergent*. The characters expressed in some of the descendants show greater resemblance than those expressed by some of the ancestors.

6 (a) *Primitive*. The character expression is an early one in a given lineage and is relatively simple or generalized.

(b) *Specialized*. The character expression is not an early one for a given lineage and shows considerable departure from the primitive condition, either in the direction of increase or decrease in complexity.

The above terms are the principal ones if not the only ones needed for critical systematic and phylogenetic analysis. Note that the term analogy has been left out of the list. As defined by Owen to refer to a similarity in use of parts without structural implications it is of little importance and should be reduced in the extent of its usage, for in the absence of valid evidence to support the transmission of somatic acquirements and especially those "due to use" we should put such a characteristic in its proper place at the end of the list where the least important terms are to be seen. There is no justification in biology for trying to make analogous the opposite of homologous or equivalent to polyphyletic or as signifying important functional characteristics or a dozen other things. Neither is there adequate basis for attempting to force homology to mean homophyly much less homogeny. Homology is a broad structural concept and should not be restricted on the uncertain basis of the question of evolutionary derivation. The word homophyly carries exactly the needed implication of common ancestry and has done so since its introduction by Haeckel (1866). As conceived by Owen and T. H. Huxley, homology gains in effective meaning and challenges us to study the objective criteria of

essential structural similarities freed of the miasmatic mists of speculation about unknown ancestry. If this is "transcendental" morphology let us make the most of it!

Summary

Progress in the understanding of the biological significance of structural resemblance and difference and the effective use of knowledge gained in comparative zoology as applied to the problems of taxonomy and phylogeny require a clear appreciation of the mechanisms, meanings and interrelations of the concepts of homology and analogy. Two main ideas have been associated with the term homology (1) essential structural similarity (2) common ancestry. Many kinds of ideas covering all the range from essential structural similarity to superficial structural similarity and from common origin to separate origin, also similarity in use or function have been associated with the term analogy.

The original and necessary concept in homology is essential structural similarity. The secondary meaning for homology of common phylogenetic origin has no place in serial homology and a role of secondary importance in special homology because in speical homology essential similarities must be recognized first before ancestry can be assumed and always special homologues are not only required to show such essential similarities but they must be of such a nature as to leave no real doubt of their structural *correspondence*.

The criteria for the recognition of serial and special homologies are essentially the same, i.e., a fundamental similarity in the structure and development and in the relative position and connections of corresponding parts of the bodies of the same or different organisms. So also the mechanisms of these two kinds of structural correspondence operate on the basis of the interaction of genes and cytoplasms. There are, however, *significant* differences in the way in which these mechanisms operate and furthermore they generally have the most diverse meanings to the naturalist for the resemblances and differences in serial homologues are intraindividual and have no direct bearing upon problems of systematic zoology and phylogeny whereas the resemblances and differences in special homologues are the primary data, the very foundation of taxonomic and phylogenetic analysis. Clear thinking requires either that different terms should be used for these two kinds of homology[3] or at least that no doubt be left in the minds of the reader as to which kind of homology is meant in any particular discussion.

The situation in regard to analogy and therefore the relations of analogy to homology has been almost hopelessly confused. The most promising ways out are either to drop the term completely or to take some simple ancestral meaning of the term which is relatively unimportant. By no means should we attempt to use analogy as the opposite of homology. For this purpose there is a simple and effective terminology, i.e., *non-homology* to be used as the oppo-

3 Owen, understanding the real differences between serial and special homology far better than some recent authors (Hubbs 1944, Moment 1945), used the term homotypy in 1848 as synonymous with serial homology and thus wrote effectively about both.

site of homology. Owen's meaning for analogy was a similarity in use to the organism *without any prerequisites as to structure*. This could be an effective use of the term — no other do I know.

The recent attempts to extend the meaning of homology to functional correspondences due to common ancestry (Hubbs, 1944) or to similar behavior (Emerson, 1946) are not well considered for several reasons. (1) If it is often difficult to demonstrate common ancestry on the basis of structural characteristics it is even more difficult to do so on the basis of physiological correspondences in the complete absence of fossil physiology. (2) The broadening of the term homology to include all kinds of physiological correspondences will rob it of its usefulness as a fairly definite kind of correspondence and will immediately require other terms to specify the kind of correspondence meant. A certain amount of consideration for our heritage of words is indispensable to effectiveness of thought. Homology has had a morphological connotation for a century and a half. I regret the current inflationary tendency to spread this term over so many more kinds of similarity as may be included in physiological or behavioristic comparisons. This will devalue the term homology and gain us no useful advantage.

Some modern systematists incline toward the view that intrinsic physiological mechanisms may be decisive in determining homologies. This view is presented by Tait (1928) and is apparently acceptable to others, e.g., Hyman (1942). However the absence of fossil physiology is a severe restriction upon the use of this criterion in phylogeny and even in existing species and *living individuals* the functional criterion is often inapplicable at times during life and is never applicable to parts which do not function. To consider intrinsic functional mechanism as the "ultimate test" of homology is to attach a far greater importance to it than the nature of the facts warrants.

Finally, the term to indicate a common phylogenetic origin of structures or functional processes wherever such can be reasonably established, is now, and has been since its introduction, homo- or mono-phyletic. Let homology represent the great idea of structural correspondence which is now and always has been the central concept of comparative morphology and of taxonomy and phylogeny as well. Let us realize once and for all that ancestry is inferred from essential similarities and that therefore it is our supreme task to study and compare and analyze these and then to classify organisms according to the amounts and kinds of such resemblances revealed in our researches.

There is a challenge to biologists in these recent papers dealing with homology and analogy. It is to compare and critically analyze the central concepts discussed with regard to their history and their limitations. These papers have each their good and bad points but now for the first time it may be possible for the biologist to choose among the various meanings of these basic terms with some clear understanding of the implications of his choice. My own analysis leads to the denial of *any* ancestral implication in serial homology and to emphasize the essential structural similarities rather than ancestry in special homology. But I do not intend to deny history — rather to try to make it

natural history. I believe that if biologists accept the challenge to compare and evaluate these concepts, and honestly to accept their limitations that we shall make rapid progress in clarity of expression and effectiveness of thinking. Systematic thinking is the first essential in systematic zoology.

REFERENCES

BATHER, F. A. 1927—Biological Classification, Past and Future. Quart. Jr. Geol. Soc. London **83**:62-104.

BELL, W. B. 1905—Modifications in size, form, and function of homologous Crustacean appendages. Thesis; University of Iowa, pp. 1-38.

BOYDEN, A. 1935—Genetics and Homology. Quart. Rev. Biology **10**:448-451.

———1943—Homology and Analogy: a century after the definitions of 'Homologue' and 'Analogue' of Richard Owen. Quart. Rev. Biology **18**:228-241.

BORRADAILE, L. A. AND F. A. POTTS.—1936 The Invertebrata. New York, Macmillan Co.

BROOKS, W. K. AND F. H. HERRICK. 1891—The Embryology and Metamorphosis of the Macroura. Mem. Nat. Acad. Science **5**:319-576.

CALMAN, W. T. 1909—Crustacea. *In* Lankester's Treatise on Zoology. Part 7. London, A. & C. Black.

DARWIN, C. 1859—The Origin of Species. New York, Appleton Co.

DE BEER, G. R. 1928—Vertebrate Zoology. New York, Macmillan Co.

———1938—Evolution. Oxford University Press.

EMERSON, A. E.—1946 Why Termites. Vice-presidential address at Boston meeting of A.A.A.S. delivered to the American Society of Zoologists.

GEGENBAUR, C. 1878—Elements of Comparative Anatomy. Trans. by F. J. Bell. London. Macmillan Co.

GEOFFROY SAINT-HILAIRE, E. 1818—Philosophie anatomique. Paris.

GURNEY, R. 1942—Larvae of Decapod Crustacea. Pub. Ray Society **129**.

HAAS, O. AND G. G. SIMPSON. 1946—Analysis of some Phylogenetic Terms, with attempts at Redefinition. Proc. Amer. Phil. Soc. **90**:319-347.

HAECKEL, E. 1866—Generelle Morphologie der Organismen. Berlin, G. Reiner.

HERRICK, F. H. 1896—The American Lobster: A Study of its Habits and Development. Bull. U.S. Fish Commission **15**(1895).

HUBBS, C. 1944—Concepts of Homology and Analogy. Amer. Naturalist **78**:289-307.

HUXLEY, J. 1928—Introduction. *In* De Beer, Vertebrate Zoology. New York, Macmillan Co.

HUXLEY, T. H. 1880—The Crayfish. New York, Appleton Co.

HYMAN, L. H. 1942—Comparative Vertebrate Anatomy. Univ. of Chicago Press.

JACOBSHAGEN, E. 1925—"Allgemeine vergleichende Formenlehre der Tiere. Leipzig, Klinkhardt.

KRAUS, R. 1897—Ueber specifische Reactionen in keimfreien Filtraten aus Cholera,

Typhus, und Pest—bacillen Culturen, erzeugt durch homologes Serum. Wiener klin. Wochenschr. **32**:736.

LANKESTER, E. R. 1870—On the use of the Term Homology in Modern Zoology, and the Distinction between Homogenetic and Homoplastic Agreements. Ann. and Magazine Nat. Hist. **6**:35-43.

MACLEAY, W. S. 1825—Remarks on the Identity of certain general Laws which have been lately observed to regulate the natural Distribution of Insects and Fungi. Trans. Linn. Society **14**:46-68.

MOMENT, G. B. 1945—The relationship between serial and special homology and organic similarities. Amer. Nat. **79**:445-455.

MOORE, C. R. 1944—Gonad Hormones and Sex Differentiation. Amer. Nat. **78**:97-130.

NOWIKOFF, M. 1935—Homomorphie, Homologie und Analogie. Anat. Anz. **80**: 388-392.

OWEN, R. 1843—Lectures on the comparative anatomy and physiology of the invertebrate animals. London. Longman, Brown, Green, Longmans.

———1847—Report on the Archetype and Homologies of the Vertebrate Skeleton. Rep. Brit. Assn. Adv. Sci. 16th meeting: 169-340.

———1848—On the Archetype and Homologies of the Vertebrate Skeleton. London. J. Van Voorst.

SHULL, A. F. 1929—Principles of Animal Biology. New York. McGraw-Hill Co.

SNODGRASS, R. E. 1935—Principles of Insect Morphology. New York. McGraw-Hill Co.

STRICKLAND, H. E. 1846—On the Structural Relations of Organized Beings. Philos-Mag., 3rd ser. **28**:354-364.

TAIT, J. 1928—Homology, Analogy and Plasis. Quart. Rev. Biology **3**:151-173.

VAVILOV, N. I. 1922—The law of homologous series in Variation. Jour. Genetics **12**:47.

WRIGHT, S. 1934—Genetics of Abnormal Growth in the Guinea pig. Cold Spring Harbor. Symposia Quantit. Biol. **2**:137-147.

RUTGERS UNIVERSITY,
NEW BRUNSWICK, N. J.

The Charleston Woody Flora

Kenneth W. Hunt

CONTENTS

Introduction

The effort which led to this catalogue dates from 1937, when the College of Charleston (S. C.) added to its curriculum a preforestry program, including courses in botany. The procurement of plants for the teaching of systematic botany is less simple than that of books for English literature or instruments for physics. The botanist must take inventory of his region and compile his own catalogue; he must himself procure, process and deliver the material until he has a complete supply (the herbarium) on hand; and he must make out instructional literature based on this supply, which unlike that of English or physics is peculiar to each region. Then he can begin to teach.

Where larger institutions exist, all this has been done, and their smaller neighbors share in the benefits. The Southeastern Coastal Plain, however, is not so fortunate. The institution that completes the process for the Coastal Plain will perform a service to its neighbors and close a considerable gap in the knowledge of the North American flora.

My own limited effort in this direction must now be brought to a close. The herbarium includes some 1250 labeled species, though critically determined only in the pteridophytes and in the woody plant group. There seemed time to bring together the accumulated data on the woody plants into a catalogue, though as the date of departure for other work nears and numerous questionable items remain, it is offered with considerable misgiving. My hope is that others will mend the errors and carry forward the study of Charleston's flora.

ACKNOWLEDGMENTS

The writer is indebted to several specialists for their generous and valued aid in determining specimens, and for their suggestions regarding keys and nomenclature, as follows: Dr. L. H. Bailey—*Rubus, Vitis;* Dr. Carleton R. Ball—*Salix;* Dr. W. H. Camp—Ericaceae, particularly *Vaccinium;* Dr. R. T. Clausen—*Robinia hispida;* Dr. Ralph O. Erickson—*Clematis;* Dr. G. Neville Jones—*Amelanchier;* Dr. C. H. Muller —*Quercus;* Mr. E. J. Palmer—*Castanea, Quercus* hybrids, *Crataegus, Amorpha, Tilia, Fraxinus;* Dr. H. W. Rickett—*Cornus, Nyssa;* Dr. H. K. Svenson—*Ascyrum, Hypericum, Viburnum.* Professor M. L. Fernald kindly supplied criticism of the catalogue as a whole. The writer is of course responsible for the manner of presentation of these groups herein and for all errors and omissions in the catalogue and keys. In the construction of the latter he has drawn freely from *Keys to Woody Plants,*[33] and gratefully acknowledges permission to do so from one of his former teachers, Dr. W. C. Muenscher. Appreciation is due another teacher, Dr. Arthur J. Eames, for his heartening encouragement of the work.

Comments and criticisms on the first draft of the manuscript were kindly supplied by the following: Laura M. Bragg, W. C. Coker, J. Harold Easterby, H. Clyde Eyster, J. Hampton Hoch, Elizabeth M. Horlbeck, W. C. Muenscher, E. J. Palmer, H. R. Totten, Paul R. Weidner, and B. W. Wells.

Real appreciation is expressed for the hearty cordiality and help extended by the directors and staffs of the New York Botanical Garden, the Arnold Arboretum, the Gray Herbarium, the Charleston Museum, and the departments of botany at the University of North Carolina and Duke University.

Many people in Charleston have aided the writer by their collections or other assistance. Those who have contributed unusual plants are named in the catalogue. Especial acknowledgment is made here to Laura M. Bragg, Elizabeth M. Horlbeck, Foster N. Martin, and Mary V. Powers.

The program which led to this catalogue was planned at Mountain Lake Biological Station of the University of Virginia, where the writer was privileged to spend a summer through a General Education Board Fellowship. Much of the work itself was supported by a grant from the Penrose Fund of the American Philosophical Society, which is here gratefully acknowledged.

Plant Science in Charleston

Many distinguished names in botany are associated with Charleston [4a,21,27]. Famous travelers, including Mark Catesby and later John and William Bartram, found Charleston a convenient base for their journeys southward. The Charleston region presently became the home of four great pioneers of American botany: Thomas Walter, André Michaux, François André Michaux, and Stephen Elliott. Charleston surnames are commemorated in the genera *Elliottia, Gaillardia, Gardenia, Macbridea, Pinckneya,* and *Poinsettia.*

Of particular interest to botanists is the site of Michaux's Charleston home and plant nursery, located on the north edge of the present Army Air Base[9,15,44]. André Michaux came here with his son, François André, in 1786 or 1787. While the father roamed Eastern North America, the son cultivated here the plants intended for shipment to France. In addition, a number of ornamentals of the Old World were cultivated here, and distributed to Charleston planters. Among these François André mentions *Ginkgo biloba, Firmiana platanifolia,* and *Albizzia Julibrissin*[31]. Others said

to have been introduced to Charleston by the Michaux are *Camellia japonica, Sapium sebiferum*[1], *Lagerstroemia indica,* and a "Chinese azalea" (one of the *Rhododendron indicum* group?). Charleston's world-famous gardens of to-day owe much of their beauty to this generosity of the Michaux.

Plants still present at this site of the Michaux Garden which do not occur elsewhere in our area are *Pinckneya pubens, Acer barbatum, Brunnichia cirrhosa, Fraxinus americana,* and *Cornus Amomum.* Other species present which appear to have been cultivated by the Michaux include *Magnolia grandifllora, Calycanthus floridus, Quercus virginiana, Lagerstroemia indica, Vitis Labrusca,* and *Albizzia Julibrissin.* The list would doubtless have been larger[9] prior to 1942, when the Army cleared the higher ground for watch-dog kennels.

Efforts by the Charleston Museum to convert the Michaux Garden into a memorial park have so far not succeeded, although a fund raised by Miss Laura M. Bragg, formerly director, provided fencing (now gone) and a historical sign. A Michaux Memorial would indeed be appropriate, especially at this place which may conceivably become a crossroads of international air traffic. Instead of the kennels of the watch-dogs of war, this land might support an arboretum, dedicated to the generous and creative spirit of the Michaux and their science.

To resume the story: the botanical pioneers for the most part collected over wide territories, erecting a framework of knowledge to be filled in by others. In South Carolina the filling-in is far from complete. It was begun by Gov. Drayton[28], then notably advanced by Dr. John Bachman, who published in 1835 a list of 1030 species collected within nine miles of Charleston[2]. Unfortunately Bachman's listings cannot be confirmed, since his herbarium was presumably destroyed in the burning of Columbia (where he had sent it for safekeeping). Eight of the woody plant species which have not since been collected here are included in the present keys, but cannot be admitted to the catalogue. They are here quoted as a challenge to future collectors[2]:

"*Andromeda ferruginea* L."—*Lyonia ferruginea* Walt.
"*Bumelia lanuginosa* Mich."
"*Chamaerops hystrix* Fraser"—*Rhapidophyllum hystrix* (Fraser) H. Wendl.
"*Clematis virginiana* L."
"*Laurus melissaefolium* Walt."—*Lindera melissaefolium* (Walt.) Bl.
"*Lycium carolinianum* Walt."
"*Ptelea trifoliata* L."
"*Salix tristis* Ait."

Several other contributions of importance occurred before the fateful year of 1860. Near Walter's region, collections were made by Dr. Henry W. Ravenel, the mycologist[36], by the Rev. Cranmore Wallace while rector

1 But this was observed in Charleston in 1784 by Schoepf.[41a]

2 Dr. Edgar T. Wherry reports the presence of some of Bachman's plants at the Academy of Natural Sciences, Philadelphia; these had been given by Dr. Bachman to Dr. Charles W. Short. They do not include any of the eight here listed.

of St. John's Berkeley, and by Dr. F. P. Porcher of the Medical College, the author of *Resources of Southern Fields and Forests*[34,35]. (These collections include a number of woody plants which have not been found within the radius of this catalogue, but are included in the keys.) Further contributions were made by two leaders of the Elliott Society. One, Dr. Lewis R. Gibbes of the College of Charleston, described several new species and accumulated an herbarium which is now at the New York Botanical Garden[17,18]. The other, Wm. Wragg Smith, undertook a detailed manual of the low country, but all that exists of it in publication is the introduction and five genera of the Ranunculaceae[45]. With the exception of Ravenel, who became the foremost American mycologist, these men's efforts were blighted by the same holocaust of war which destroyed Bachman's herbarium.

Later in the nineteenth century excellent collections were made by Dr. J. H. Mellichamp of Bluffton in the south of the State, and partly because of this stimulus, numerous noted botanists have visited Coastal Carolina since 1900[8]. These include C. S. Sargent, H. H. Rusby, R. H. Harper, Wm. Trelease, C. R. Ball, B. L. Robinson, W. C. Coker, W. W. Ashe, T. G. Harbison, and J. K. Small. Meanwhile, at the Charleston Museum, Miss Laura M. Bragg achieved a revival of local botanical interest and began a program directed toward a State flora[4]. Her collections constitute a large part of the Museum herbarium, and the plant index she compiled records the collections of most of the botanists here named. This material provides a valuable foundation for future work.

More recently, other visitors have passed this way, including H. R. Totten (University of North Carolina), K. M. Wiegand and W. E. Manning (Cornell), R. T. Clausen and Harold Trapido (Cornell), H. N. Moldenke (New York Botanical Garden), H. W. Trudell (Philadelphia) and E. T. Wherry (University of Pennsylvania), M. L. Fernald and Bayard Long (Harvard), and R. K. Godfrey and R. M. Tyron, Jr. (Minnesota). Horry County to the north has been botanized by C. A. Weatherby and Ludlow Griscom (Harvard) and by S. A. Ives and his students (Furman). Yet the fact that much still remains unnoticed is indicated by the paper of Dr. Budd E. Smith of Coker College, read at the April, 1946, S. C. Academy of Science meeting, listing 53 herbaceous and 6 woody species from Darlington County which are new to the previously reported flora of South Carolina.

This record of two centuries of plant collecting is a notable one, but it is significant that Charleston is still without a completed plant catalogue, and that most of the surviving collections repose elsewhere. (What remain here are those of Elliott, Wallace, and Bragg, plus fragments of the collections of Ravenel, Porcher, and Gibbes, all at the Charleston Museum[4,49].) The loss of benefit to Charleston is due to the fact that scientific material and effort gravitate to the centers best equipped to accommodate them. That this has happened in taxonomic botany is perhaps without serious practical consequences to Charleston, except for the handicap it imposes on teaching. But today plant science is much more than taxonomic botany. It includes branches of vital significance to this region, such as ecology, forestry, plant

breeding, horticulture, agronomy, and pasturage research[51]. Such modern plant science is now active here. Will its benefits fully accrue to us, or will they be left undeveloped and dispersed, as happened with the older botany?

The modern research institutions near Charleston are the U. S. Regional Vegetable Breeding Station, the South Carolina Truck Experiment Station, the Coastal Experiment Station (for feed crops), and the Francis Marion National Forest, including the Santee Experimental Forest. Less close to plant science, but concerned with it, are the Cape Romain and the Santee Wildlife Refuges. At this writing the Bear's Bluff Laboratories are being organized by G. Robert Lunz to undertake a comprehensive program of marine and field biological research. The efficiency of all these organizations depends to a large degree on local backing and services. A strong academic center of botany (or of biology, in the full sense) could be of great value to them, could serve to acquaint the public with the significance of such work, and could see to it that its benefits are this time fully conserved and developed. The losses of the past were perhaps inevitable in a tragic phase of history, but if adequate measures are taken now they need not be repeated.

At Charleston are four centers of learning: the Medical College, the Citadel, the College of Charleston, and the Charleston Museum. All are potentially capable of effective botanical or biological field studies and instruction. Charleston is the only such academic center north of Florida on the Southeastern Coastal Plain. This Coastal Plain, as compared with the Piedmont, is a relatively empty land, with its crop acreage limited, its herds of low value, its forests half-productive, its population sparse and far from prosperous. With such a hinterland no city can thrive. When Charleston's educational institutions join its field stations in a concerted scientific attack, new levels of production will be attained, surpassing the plantation days of old.

The Charleston Area

The Charleston woody flora, as treated here, is supported essentially by the drainage areas of the Ashley and the Cooper rivers ("which meet at Charleston to form the Atlantic Ocean"). The twenty-five mile radius selected excludes only the Cooper headwater area (the old Santee Canal region, now marked by the Pinopolis Reservoir). Excursions made just beyond this radius to the narrow Edisto basin, at Penny Creek and at Leveston Bluff, gleaned only two additional entities: another hawthorn, *Crataegus spathulata,* and a variety of the deciduous holly, *Ilex decidua* var. *Curtissii.* Excursions to the Santee would reveal more; plants have been collected there and northward which do not reach the Charleston area. To the southward, additional species could be found if one crossed the Combahee and went on to the noted Bluffton region.

The soils of the Charleston area have been developed from the Pleistocene and Recent sea sediments of sand and clay, which are spread along the Coastal Plain in a series of terraces[7]. The Recent sediments blanket the Sea Islands and immediate mainland, and border the estuaries. The general

cover elsewhere is the Pamlico formation, but this is interrupted by large patches of the Talbot formation which were the sea islands of Pamlico time. In the Summerville region, where the elevation is over 42 feet, the still older Penholoway formation is at the surface. These Pleistocene and Recent sediments are usually but two or three feet thick, except under Charleston, where the well at the foot of Charlotte Street shows 56 feet of them.

Underlying the Pleistocene sediments generally is the Hawthorn formation of Miocene age, varying from a sandy phosphatic marl to a soft limestone. Small patches of the Duplin shell marl (Miocene) lie upon this at Summerville and at Dean Hall, and similarly a patch of Waccamaw shell beds and sand (Pliocene) occurs around Yeamans Hall. The Hawthorn formation varies from 1 foot to over 30 feet thick, and is everywhere underlain by the thick Cooper marl of Eocene age. Exposures of the Hawthorn and Cooper formations are frequent along stream banks, as at Bacon's Bridge on the Ashley.

Through much of the Charleston area a bed of nodular phosphate rock occurs at the base of the Hawthorn formation, on the average roughly 10 feet below the ground surface[48]. This was extensively mined between 1867 and 1925, an operation that left wide areas of ridges and long water-filled excavations. Examples of these may be observed along the Ashley River Road near Magnolia Gardens, now covered by a mixture of pine woods and wet woods vegetation. It might be interesting to study the plant succession in these localities where the underlying marls have been mixed with the surface.

Drainage in the Ashley-Cooper basin is still in the initial stage. After rains the water stands on the flat surface over wide areas, although during drought the same areas may become parched. In such country fires are frequent, and in places the woody plants have been driven off, leaving a savannah of grasses and sedges (grass-sedge bog)[51]. An example of this occurs across the Berkeley County line from Summerville, west of Rt. 64. Other very extensive areas, as at Caw Caw Swamp, are so close to high-tide level that the water seldom subsides below the surface (yet even these occasionally burn). Since the highways trend along the sandy ridges of Pleistocene dunes and bars, the large proportion of swamp and bog land is not apparent to the traveler. Yet there is diversity too. Distinctive types of vegetation border the shore, the marshes, the swamps, the streams. Frequent areas of better-drained and loamy soil support rich woods. Hence well-defined plant communities have formed which can be correlated with the habitats.

Such a correlation has been attempted for the purposes of this catalogue. Unfortunately, no ecological study has yet been made of the South Carolina Coastal Plain, but the work of Wells in North Carolina[52] and of Laessle in Florida [25] are most helpful. In the following table, our most conspicuous habitats are correlated, so far as possible, with the plant communities which Wells and Laessle describe.

The following list of twelve habitats includes only the territories sustaining

some woody plant growth. Savannahs and marshes, having almost entirely an herbaceous growth, are not listed, nor are the plant communities which correlate with them.

Habitats here described for Charleston, S. C.	*Correlation with plant communities of North Carolina (Wells)*	*Correlation with plant communities of Florida (Laessle)*
I. Shore communities		
1. Beach dunes	Xeric dunes	....
2. Salt marsh borders	Xeric salt marsh	....
3. Shore woods	Maritime forest	....
II. Pine communities		
4. Old fields	Meadow	Slash pine flatwoods Black pine flatwoods Longleaf pine flatwoods
5. Pine woods	Meso-xeric pine forest	Sandhills Scrub Xeric hammock
6. Dry sandy woods	Xeric coarse sand ridge	
III. Hardwood communities		
7. Moist rich woods	Mesophytic broad-leaved forest	Mesic hammock
8. Wet woods	....	Hydric hammock
9. Cypress swamps	Swamp forest	River swamp
10. Stream banks	....	....
IV. Bog communities		
11. Bays	Shrub bog	Bayhead
12. Seepage slopes	....	....

By use of material in the College of Charleston herbarium (including 1951 mounted sheets of woody plants), supplemented by the writer's field notes, the distribution of our woody plant species has been charted according to these twelve habitats. (The chart is deposited with the herbarium.) This is the basis of the statements on habitats and frequency throughout the catalogue. It is also the basis of the following lists of the species which are most characteristic in each of the habitats. An asterisk (*) indicates a species which is confined, or nearly confined, to the one habitat. The arrangement of plants in each list is alphabetical, without significance as to frequency.

1. Beach Dunes

These are limited to the barrier beaches, such as Edisto, Folly, and the Isle of Palms. The term includes the older stabilized dunes as well as those close to the water. It does not include the Pleistocene dunes inland, which support the dry sandy woods to be described farther on.

**Croton punctatus*
**Iva imbricata*
Opuntia Drummondii
Opuntia macrarthra
Smilax auriculata
Yucca aloifolia
Yucca filamentosa
Zanthoxylum Clava-Herculis

2. Salt Marsh Borders

This habitat is only a few feet or yards in width, but extends in tortuous fashion for scores of miles around the sea islands and salt creeks that divide up so much of this area. Where the marsh meets definitely rising land this

habitat merges with that of the seepage slope, as is indicated by the presence of *Ilex Cassine* on this list. One of the members is so continuous that this State might be regarded as bounded by North Carolina, Georgia, and *Borrichia frutescens!*

**Baccharis angustifolia*
Baccharis halimifolia
**Batis maritima*
**Borrichia frutescens*
Ilex Cassine
Ilex vomitoria
**Iva frutescens*
Juniperus silicicola
Sabal minor
Sapium sebiferum
Smilax auriculata
Yucca aloifolia
Yucca filamentosa

3. SHORE WOODS

These are best developed in the lee of the beach dunes, although also extending less distinctly inland from the salt marsh borders. Some of the smaller Sea Islands are completely of this habitat, and are the basis for calling South Carolina the "Palmetto State." *Pinus Taeda* invades the shore woods but is killed back by the occasional hurricanes. *Pinus caribaea* seems more resistant to salt, and in fact here is confined to this habitat of moderated temperatures. The "stream-lined" appearance of the shore woods has been explained by Wells and Shunk as due to salt spray damage to the buds[53].

Bumelia tenax
Osmanthus americanus
**Persea Borbonia*
**Pinus caribaea*
Prunus caroliniana
Quercus virginiana
Quercus virginiana var. *geminata*
**Sabal Palmetto*
Smilax auriculata
Yucca aloifolia

4. OLD FIELDS

These are areas which are reverting to natural growth following cultivation. A great diversity of plants from various habitats may spring up here; this list has been arbitrarily limited. Succession develops rapidly until the appearance of pine woods, dry sandy woods, or rich moist woods is attained, depending on the conditions of soil, moisture, and the frequency of fires. Many of the Sea Island woodland areas have passed through this old field stage, which in turn was a consequence of the destruction of Sea Island cotton by the boll weevil. In such woods the plow furrows are still distinct, due to the absence of frost heaving in this mild climate.

Ampelopsis arborea
Baccharis halimifolia
Broussonetia papyrifera
Campsis radicans
Celtis laevigata
Liquidambar Styraciflua
Lonicera japonica
Melia Azederach
Myrica cerifera
Nyssa sylvatica
Pinus Taeda
Prunus angustifolia
Prunus serotina
Quercus nigra
Rhus copallina
Rubus trivialis
Sambucus canadensis
Sassafras albidum
Smilax Bona-nox
Smilax glauca
Vitis aestivalis
Vitis rotundifolia

5. PINE WOODS

These occupy sites quite diverse in moisture and soil conditions, and are an arrested stage in succession (fire sub-climax) rather than the result of a definite habitat. Their composition is therefore unstable, with the number of species in inverse relation to the incidence of fire. The pine woods may become dry sandy woods, rich moist woods, or wet woods, if there is sufficient absence of fire; they may become pure stands of *Pinus palustris* under occasional but not severe burning; or they may become savannahs or shrub-bogs after destructive fires or clearing combined with burning. The role of fire in the management of southern pinelands is a subject of much discussion. Its literature has been reviewed by Garren[16].

In this, and in some of the other habitats subject to repeated burning, there appear low stoloniferous varieties or species which except for their habit show little distinction from related larger, non-stoloniferous species. Examples are *Castanea alnifolia* and *C. alnifolia* var. *floridana; Quercus stellata* var. *stolonifera* and *Q. stellata* var. *Margaretta* (see p. 713); and *Fothergilla parvifolia* and *F. Gardeni.* It seems possible that in each case the stoloniferous plant is merely a *forma* which has gone "underground" in response to the circumstances of fire. Experimental work on this possibility might be of interest.

Aronia arbutifolia
Ascyrum stans
Ceanothus americanus
Clethra tomentosa
Diospyros virginiana
Gaylussacia dumosa
Gaylussacia frondosa
**Hypericum cistifolium*
Ilex glabra
Leucothoe racemosa
Liquidambar Styraciflua
Lyonia ligustrina
Lyonia mariana
Myrica cerifera
Myrica pusilla
Nyssa sylvatica
Pinus palustris
Pinus Taeda
Prunus serotina
Quercus falcata
Quercus nigra
Quercus pumila
Quercus stellata var. *Margaretta*
Rhus copallina
Smilax glauca
Symplocos tinctoria
Vaccinium arboreum
Vaccinium tenellum
Vitis rotundifolia

6. DRY SANDY WOODS

These occupy somewhat higher but limited areas, the dunes, bars, and islands out from the old Pleistocene shore. Sometimes the pines become dominant, imparting to this habitat the appearance of the pine woods. The difference is in the coarser, non-capillary soil and the consequent lack of ground cover. Herbaceous vegetation is sparse with much bare sand in evidence. The trees are more widely spaced, or else are scrubby. For a time the habitat is spared from fire, for lack of inflammable litter; but as the humus builds up and the vegetation becomes thicker and more varied, the fires increase and again burn out the soil.

Carya tomentosa
Castanea pumila var. *Ashei*
Crataegus uniflora
Diospyros virginiana
Myrica cerifera
Pinus echinata

Pinus palustris
Pinus Taeda
Quercus falcata
**Quercus incana*
**Quercus laevis*
Quercus laurifolia
Quercus marylandica
Quercus stellata
Quercus stellata var. *Margaretta*
Rhus copallina
Smilax Bona-nox
Smilax pumila
Vaccinium arboreum
Vaccinium stamineum
Vaccinium tenellum
Vaccinium virgatum

7. Moist Rich Woods

This is a well-defined habitat, as indicated by the eight species which are practically confined to it. The characteristics are a loamy soil, rich humus, and adequate moisture which is percolating rather than stagnant. It is found on land slightly above the general level of the wet woods, or on some of the scarcely perceptible slopes between higher and lower levels, and along the sides of the few well-developed ravines and drainage channels. Possibly the old phosphate mines may turn into this habitat as their confused soils mature. Our moist rich woods correspond to the wider areas in the Piedmont and the northeast which are noted among nature-lovers for their handsome trees, diversity of species, and profusion of herbaceous spring wildflowers. This habitat is destroyed by too-frequent burning.

**Aesculus Pavia*
Aralia spinosa
Bignonia capreolata
Callicarpa americana
Carpinus caroliniana
Carya cordiformis
Carya glabra var. *megacarpa*
**Cercis canadensis*
**Chimaphila maculata*
Cornus florida
Decumaria barbara
**Fagus grandifolia*
**Hamamelis macrophylla*
Ilex opaca
Liquidambar Styraciflua
**Liriodendron Tulipifera*
Magnolia grandiflora
**Mitchella repens*
Morus rubra
Myrica cerifera
Nyssa sylvatica
Parthenocissus quinquefolia
**Pinus glabra*
Pinus Taeda
Quercus alba
Quercus falcata
Quercus laurifolia
Quercus nigra
Rhododendron canescens
Rhus radicans
Smilax Bona-nox
Smilax lanceolata
Symplocos tinctoria
Tilia caroliniana
Vitis aestivalis
Vitis rotundifolia

8. Wet Woods

This is the most extensive of the habitats in our area. It is illustrated by the ill-drained region between the basins of the Ashley and the Edisto, which is partially reached by Rantowles Creek. Since it lies mostly within 10 or 15 feet of mean sea-level, it is difficult to perceive any agricultural development for it at the present time. By skilful engineering in colonial and antebellum days, some of it was converted to the purposes of rice planting. Today it is forested, but with stands of poor value. It is mainly used by hunting clubs. Perhaps its best economic utilization for the present lies in the direction of wildlife development, considering the fact that the Southeastern Coastal Plain is one of the nation's richest wildlife regions. (Another suggestion appears in the discussion of the next habitat.)

Acer rubrum
Bignonia capreolata
Campsis radicans
Carya aquatica
Celtis laevigata
Cephalanthus occidentalis
Cornus stricta
Decumaria barbara
Ilex opaca
**Itea virginica*
Quercus laurifolia
Quercus phellos
Quercus Michauxii
Rhus radicans
Sabal minor
Salix Harbisonii
Smilax hispida var. *australis*
Smilax rotundifolia
Styrax americana
Taxodium distichum
**Ulmus alata*
Ulmus americana
Viburnum dentatum var. *pubescens*
Viburnum nudum

9. CYPRESS SWAMPS

These occupy the areas most constantly inundated, where the soil oxygen deficiency is too great for all but a few species, dominated by *Taxodium distichum* and *Nyssa aquatica*. Examples are seen in Caw Caw Swamp and bordering Schultz Lake. Yet even here the water level occasionally subsides below the surface. (Demaree[12] and Shunk[42] have shown that cypress and tupelo seed require air for germination.) At such times the swamp is highly vulnerable to fire, due to the thick peaty bottom. For this reason much potential cypress-tupelo area is now reduced to bays (shrub-bogs). The development of cypress in former rice reservoirs, as at Cypress Gardens, and at the Mayrant Backwater, suggests the possibility of long-range culture of these valuable timbers by controlled impoundments.

No swamp of white cedar (*Chamaecyparis thyoides*) is known to the writer within the Charleston area.

Acer rubrum
Cephalanthus occidentalis
Fraxinus caroliniana
Nyssa sylvatica var. *biflora*
**Nyssa aquatica*
Populus heterophylla
Smilax Walteri
Taxodium distichum

10. STREAM BANKS

This habitat is not to be confused with the salt marsh borders which line the tidal creeks, but refers to the few fresh-water flowing streams. The vegetation is not a well-defined plant community, being a variable blend of species characteristic of several other habitats. It is noted here because of the four species peculiar to it, plus the several others that are especially prominent.

Amorpha fruticosa var. *croceolanata*
**Betula nigra*
Carpinus caroliniana
Carya aquatica
Clematis crispa
Hypericum galioides var. *pallidum*
Planera aquatica
Quercus lyrata
Sabal minor
**Sebastiana fruticosa*
Trachelospermum difforme
**Vaccinium Elliottii*
Viburnum obovatum
**Wisteria fruticosa*

11. BAYS

The bays are wet spots, "ponds," and broad basins, containing stagnant water which fluctuates widely in level with the amount of rainfall. A very characteristic growth prevails here, recognized by Wells as the xeric shrub-bog community[52]. Many of the plants are broad-leaved evergreens, with the

thick, ligneous, waxy foliage suggestive of drought-enduring xerophytes. Many papers have been written discussing the xeromorphic character of bog plants; recently a new approach was indicated by Albrecht[1]. In the Charleston area an admirable opportunity exists to study the problem, due to the contrast presented by these stagnant bays and the floating mats on the non-stagnant Goose Creek Reservoir. The succession on the mats completely skips the bog stage of the bays[22].

These bays occur on flat undrained uplands, at the heads of drainage courses, and in depressions of disputed origin[6]. They are a dense mass of stout-branched shrubs re-enforced by a tangle of *Smilax*, sometimes almost impenetrable. Were it not for the fires which sweep across them in time of drought, they would presumably develop into either cypress swamp or wet pine woods, depending on the degree of flooding.

Aronia arbutifolia
Arundinaria tecta
Clethra tomentosa
**Cyrilla racemiflora*
Gaylussacia frondosa
Gordonia Lasianthus
Ilex coriacea
Ilex glabra
Lyonia lucida
Magnolia virginiana
**Myrica heterophylla* var. *Curtissii*
Persea palustris
Pinus serotina
Smilax laurifolia
Vaccinium crassifolium
**Zenobia pulverulenta*

12. Seepage Slopes

Where there is a marked slope between an upland and a swamp or a salt marsh, the surface is often boggy with seepage water, and supports a community which is much like that of the bay. A similar circumstance in Florida is explained by Laessle[25]. Beneath the surface of the undrained upland is an impermeable hardpan (precipitated soil salts) which prevents the soil water from moving farther downward. Hence it slowly spreads laterally, emerging as seepage where the hardpan intersects the slope. This brings to the vegetation of the slope the same kind of water that is present in the upland bay. The seepage slope evidently possesses additional factors peculiar to itself, however, since two of its species, *Alnus serrulata* and *Rhus Vernix,* appear nowhere else in our area. It can be pointed out that of our twelve woody plant habitats, this is the only one where the moisture never disappears, while also never flooding to the exclusion of air. Another factor is the excellent protection from fire which this circumstance provides.

**Alnus serrulata*
Aronia arbutifolia
Chionanthus virginicus
Ilex Cassine
Leucothoe racemosa
Lyonia ligustrina
Lyonia lucida
Myrica heterophylla
Rhododendron viscosum
**Rhus Vernix*
Smilax laurifolia
Viburnum nudum

Explanation of the Catalogue and Keys

This is a catalogue of the native and naturalized plants having aboveground stems that survive the winter and again produce leaves. On this basis, partridge-berry is included, though scarcely woody, and the ligneous-stemmed goldenrods are excluded. The acaulescent Yuccas and Dwarf Palmetto are included by courtesy — their more substantial relatives are here!

"The Charleston area" as expressed here is the land lying within a radius of twenty-five miles of the city. This is the practical limit for class field work in the usual afternoon laboratory period.

An effort has been made to include all worthy varieties as well as species, but *formae* are not mentioned, except occasionally in the discussion of a variable species. No attempt has been made to identify the hybrids. Described hybrids which might be sought here are listed under the first parent, in each case, to appear in the catalogue.

Synonymy has been cited in so far as necessary to correlate names with those of the manuals of Small[43] and of Coker and Totten[11]. Recent monographic and bibliographic research since these manuals were written has altered the names and status of many entities. To those who regret the dropping of familiar or fondly remembered names it is pointed out that the first purpose of this catalogue is the instruction of students, who should not be burdened with binomials already invalidated. The writer will gratefully receive corrections of remaining errors and oversights.

The names here used for trees conform to those of the new edition of the U. S. Forest Service *Check List,* by E. L. Little, Jr.[26], now awaiting publication. Alfred Rehder's *Manual of Cultivated Trees and Shrubs*[38] has been generally followed for shrubs and vines, in so far as it covers our flora, but in numerous instances changes have been required in conformity with subsequent periodical literature and monographs.

In the interest of uniformity the common names selected by Dr. Little for his *Check List* have been adopted, occasionally followed by a supplemental name in local usage. For shrubs and vines the local names have been more freely used. In numerous instances common names are lacking. In accordance with the practice of the Forest Service, where a common name consists of a noun and an adjective the two are kept separate only if the noun properly applies to the genus, as Black Willow for *Salix nigra.* Where the noun properly applies to a different genus, the noun and adjective are hyphenated, as Virginia-willow for *Itea virginica,* or solidified where it does no violence to euphony, as Pricklypear for *Opuntia.* Apostrophes have been omitted; for example, St. Johns-wort.

Habitats are generally designated as explained under "The Charleston Area," but when suitable such additional terms are used as roadside, pond margins, thickets, etc. Frequencies are stated in terms of the habitats, rather than for the area as a whole, and are designated as "common," "frequent," or "occasional." In the cases of plants which are unusual in our area no statements are given regarding habitat or frequency, but the localities of collection are cited. Unless otherwise designated, the specimens were collected by the writer, and are in the College of Charleston herbarium, which at present is in the custody of the Charleston Museum. (Locality designations on the

labels are expressed in terms of grid-marked local topographic maps, on file with the herbarium.) The names of other collectors are italicized, and the herbaria where their collections were observed, if not in the College of Charleston herbarium, are indicated by the following abbreviations:

AA—Arnold Arboretum	M—Charleston Museum
Cv—Converse College	NY—New York Botanical Garden
G—Gray Herbarium	UNC—University of North Carolina

Place names used by the older collectors may usually be located in the *Atlas* of Robert Mills[32], a copy of which is at the College of Charleston Library. The plantations are described by Samuel G. Stoney [46]. Other locations may be found on U. S. Geological Survey topographic maps and on current road maps.

In the construction of the keys, care was taken to give each member of a contrasting pair of leads the same indentation, numeral, and first word. Characters which seem helpful but which are non-diagnostic are in parenthesis. Variable species, such as *Quercus nigra,* may be reached by several different routes. All measurements are according to the metric system (see the back cover.) The use of technical terms has been as sparing as possible, but any attempt to separate species becomes impractical without the precision afforded by a scientific vocabulary. Therefore a Glossary has been supplied, preceding the Index.

A few hints may be helpful. In the field it pays to discriminate, avoiding abnormal material such as sucker shoots, seedlings, diseased or suppressed growth, and selecting material from the shrub or tree which is representative rather than extreme. "Twig" refers to the growth of the year, developed from buds of the spring. Such buds formed in the axils of the previous year's leaves; hence, if the leaves are persistant (plant evergreen), the old leaves usually still subtend the twigs which bear the new leaves. "Branchlet" refers to growth of small diameter more than one year old. To determine whether or not the sap is "milky," select one of the more vigorous twigs, break off a leaf, and observe the sap which presently oozes from the end of its petiole. To distinguish between a leaf and a leaflet, look for the bud which occurs in the axil of twig and petiole, but never in the angle between rachis and petiolule. Excellent illustrations of leaf, twig and inflorescence terminology are offered by Muenscher[33] and Duncan[13]. Illustrations, as well as descriptions, of the trees may be found in the works of Sargent[40], Coker and Totten[11], and Rosencrans and Prince [39]. Descriptions of all species appear in Small's *Manual*[43].

In addition to the species and varieties of the catalogue, the keys include such additional species (but not varieties, except in a few instances) as might possibly yet be found here. These are distinguished from the collected species by the use of parentheses. Plants reported by Bachman and species found by Ravenel and Mellichamp beyond our area are thus included, plus others which might be sought here on the basis of the range statements in Small's *Manual*. Quite possibly even other species are still awaiting discovery here: some known from elsewhere, others as yet unknown to science. Therefore normal specimens which fail to key out properly deserve special attention. Complete material of these may be sent to one of the larger herbaria for identification. The species and varieties included in this catalogue number 302.

Bibliography

(References pertaining to nomenclature appear in the catalogue proper under the species concerned.)

1. ALBRECHT, WM. A.—Calcium-potassium-phosphorus relation as a possible factor in ecological array of plants. Jour. Amer. Soc. Agron. **32**:411-418. 1940.

2. BACHMAN, JOHN—Catalogue of phaenogamous plants and ferns, native or naturalized, found growing in the vicinity of Charleston, South Carolina. Southern Agriculturist **8**:189-196, 286-291. 1835 (Charleston).

3. BARTRAM, WILLIAM—Travels through North & South Carolina, Georgia, East & West Florida, the Cherokee country, the extensive territories of the Muscogulges, or Creek Confederacy, and the country of the Choctaws. Philadelphia, 1791.

4. BRAGG, LAURA M.—The Museum herbaria. Bull. Charleston Mus. **8**:43-49. 1912.

4a. ———Bibliography of the sylva of South Carolina. Bull. Charleston Mus. **6**:61-68, 1910, and **7**:9-15, 1911.

5. CATESBY, MARK—The natural history of Carolina, Florida, and the Bahama Isles. London, 1731-1743. 2 v.

6. COOKE, C. WYTHE—Elliptical bays in South Carolina and the shape of eddies. Jour. Geol. **48**:205-211. 1940.

7. ———Geology of the Coastal Plain of South Carolina. U. S. Geol. Surv. Bull. **867**:1-196. 1936.

8. COKER, W. C. —Dr. Joseph Hinson Mellichamp. Jour. Elisha Mitchell Sci. Soc. **27**:37-64. 1911.

9. ———The garden of André Michaux. Jour. Elisha Mitchell Sci. Soc. **27**:65-72. 1911.

10. ———Observations on the flora of the Isle of Palms, Charleston, S. C. Torreya **5**:135-145. 1905.

11. ——— AND TOTTEN, H. R.—Trees of the Southeastern States. The University of North Carolina Press, Chapel Hill. Ed. 3, 1946.

12. DEMAREE, D.—Submerging experiments with Taxodium. Ecology **13**:258-262. 1932.

13. DUNCAN, WILBUR H.—Guide to Georgia trees. The University of Georgia Press, Athens. 1941.

14. ELLIOTT, STEPHEN—A sketch of the botany of South Carolina and Georgia. Charleston, 1821 and 1824. 2 v.

15. FRENEAU, PETER (translator).—A brief narrative of the life and travels of Andrew Michaux, a celebrated French botanist. Charleston (S. C.) City Gazette, July 20, 21, 28, 1804 (incomplete). (From the original of De Leuze, *Notice historique sur André Michaux*, Annales du Musée National D'Histoire Naturelle, 4° v. **3**:191-227, 1804.)

16. GARREN, KENNETH H.—Effects of fire on vegetation of the Southeastern United States. Bot. Rev. **9**:617-654. 1943.

17. GIBBES, LEWIS R.—Botany of Edings' Bay. Proc. Elliott Soc. Nat. Hist. **1**:241-248. 1859.

18. ———On the representatives of the genus *Cactus* in this State. Proc. Elliott Soc. Nat. Hist. **1**:272-273. 1859.

19. HARPER, FRANCIS—John Bartram: Diary of a journey through the Carolinas, Georgia, and Florida from July 1, 1765, to April 10, 1766. Trans. Amer. Philos. Soc. **33**(I):iv+120. 1942.

20. ———William Bartram: Travels in Georgia and Florida, 1773-74; a report to John Fothergill. Trans. Amer. Philos. Soc. **33**(II):121-242. 1943.

21. HORLBECK, E. M.—Notes on contributions to the science of botany in South Carolina. Mimeographed, in College of Charleston Library.

22. HUNT, KENNETH W.—Floating mats on a Southeastern Coastal Plain reservoir. Bull. Torrey Bot. Club **70**:481-488. 1943.

23. ———Some heretofore unnoticed plants of the South Carolina Coastal Plain. Rhodora **47**:142-143. 1945.

24. IVES, SUMNER A.—The vascular plants of Horry County, South Carolina. The Furman Bulletin **20**, no. 9: 25-40. 1938.

25. LAESSLE, A. M.—The plant communities of the Welaka area. Univ. of Fla. Biol. Sci. Ser. **4**: no. 1. 1942.

26. LITTLE, ELBERT L., JR.—Check list of the native and naturalized trees of the United States, including Alaska. Mimeographed edition, Forest Service, U. S. Dept. of Agriculture, Washington, D. C. 1944.

27. McGEE, WILSON—South Carolina botanists. Bull. Univ. of S. C. no. 72. 1918.

28. MERIWETHER, MARGARET BABCOCK (editor)—The Carolinian Florist of Governor John Drayton of South Carolina, 1766-1832. The South Caroliniana Library of the University of South Carolina, Columbia, S. C. 1943.

29. MICHAUX, ANDRÉ—Flora Borealis Americana. Paris, 1803.

30. MICHAUX, FRANÇOIS ANDRE—The North American Silva. Philadelphia, 1817.

31. ———Travels to the westward of the Alleghany mountains, in the States of Ohio, Kentucky, and Tennessee, and return to Charlestown, through the upper Carolinas. London, 1805. Trans. by B. Lambert.

32. MILLS, ROBERT—Atlas of the State of South Carolina. Baltimore, 1826.

33. MUENSCHER, W. C.—Keys to woody plants. Published by the author, Ithaca, N. Y. Ed. 5, 1946.

34. PORCHER, FRANCIS PEYRE—A medico-botanical catalogue of the plants and ferns of St. John's Berkeley, S. C. South. Jour. Med. and Pharm. **2**:255-286, 397-417. 1847.

35. ———Resources of the southern fields and forests. Charleston, 1863.

36. RAVENEL, H. W.—Catalogue of the natural orders of plants in the vicinity of the Santee Canal, as represented by genera and species. Proc. Amer. Assoc. Adv. Sci: **3**:2-17. 1850.

37. ———A list of the most common native and naturalized plants of South Carolina. *In* South Carolina; resources and population, institutions and industries, Chapt. XII, pp. 312-359. Charleston: State board of agriculture of South Carolina. 1883.

38. REHDER, ALFRED—Manual of cultivated trees and shrubs hardy in North America, exclusive of the subtropical and warmer temperate regions. The Macmillan Co., New York. Ed. 2, 1940.

39. ROSENKRANS, D. B. AND PRINCE, A. E.—Common trees of South Carolina. Clemson Agricultural College, Clemson, S. C., and South Carolina State Commission of Forestry, Columbia, S. C. 1944.

40. SARGENT, C. S.—Manual of the trees of North America. Houghton Mifflin Co., Boston and New York. Ed. 2, 1933.

41. SARGENT, C. S. (editor)—Portions of the journal of André Michaux, botanist, written during his travels in the United States and Canada, 1785 to 1796. Proc. Amer. Philos. Soc. **26**(129):1-145. 1889.

41a. SCHOEPF, JOHANN DAVID—Reise durch einige der mittlern und südlichen Vereinigten Nordamerikanischen Staaten nach Ost-Florida und den Bahama Inseln unternommen in den jahren 1783 und 1784. Extracts from the translation by Alfred J. Morrison, Bull. Lloyd Library of Bot., Pharm., and Mat. Med. **16**:1-39. 1911.

41b. SHECUT, J. L. E. W.—Flora Carolinaensis, Charleston, 1806. 2 v. (Contrary to the title, an attempted compilation of the world flora, though with added comments on local plants.)

42. SHUNK, I. V.—Oxygen requirements for germination of seeds of *Nyssa aquatica*, tupelo gum. Science **90**:565-566. 1939.

43. SMALL, J. K.—Manual of the southeastern flora. Published by the author, New York. 1933.

44. SMITH, HENRY A. M.—(For the section on the "French Garden" in his article on —) Goose Creek. S. C. Historical and Genealogical Mag. **29**:8-11. 1928.

45. SMITH, WM. WRAGG—Flora of the lower country of South Carolina reviewed. Jour. Elliott Soc. Nat. Hist. **1**, article 1, 1-41. Charleston, 1859.

46. STONEY, SAMUEL GAILLARD—Plantations of the Carolina low country. Charleston, 1939.

47. WALTER, THOMAS—Flora Caroliniana. London, 1788.

48. WATKINS, J. H.—Origin of the phosphate deposits of the southeastern states. Doctoral dissertation, the University of North Carolina. 1941.

49. WEATHERBY, C. A.—A list of type specimens in Elliott's herbarium. Rhodora **44**: 249-264. 1942.

50. ——— AND GRISCOM, LUDLOW—Notes on the spring flora of the Coastal Plain of South Carolina north of Georgetown. Rhodora **36**:28-55. 1934.

51. WELLS, B. W.—Ecological problems of the Southeastern United States Coastal Plain. Bot. Rev. **8**:533-561. 1942.

52. ———Plant communities of the Coastal Plain of North Carolina and their successional relations. Ecology **9**:230-242. 1928.

53. ——— AND SHUNK, I. V.—Salt spray: An important factor in coastal ecology. Bull. Torrey Bot. Club **65**:485-492. 1938.

Key to the Groups

1. Leaves much reduced: needle-like, scaly-like, cylindric, or lacking .... A, p. 686
1. Leaves developed, with flat blades.
  2. Above-ground stems lacking: leaves from ground level .... B, p. 687
  2. Above-ground stems developed.
    3. Leaves opposite or whorled.
      4. Blades compound .... C, p. 687
      4. Blades simple .... D, p. 688
    3. Leaves alternate or spiraled.
      5. Blades compound .... E, p. 691
      5. Blades simple .... F, p. 693

Keys to the Genera

A. LEAVES NEEDLE-LIKE, SCALY, CYLINDRIC, OR LACKING.

1. Stems fleshy (stem green, usually flattened or spiny; leaves lacking) .... *Opuntia* p. 737
1. Stems woody.
  2. Leaves fleshy: half-cylindric or club-shaped.
    3. Arrangement of leaves opposite; spines absent .... *Batis maritima*, p. 718
    3. Arrangement of leaves alternate; spines present .... *(Lycium carolinianum)*
  2. Leaves not fleshy: needle-like or scaly.
    4. Stems creeping, forming a low mat .... *(Pyxidanthera barbulata)*
    4. Stems upright: shrubs or trees.
      5. Foliage scaly (leaves appressed to the twig and concealing it).
        6. Leaves opposite, in four ranks on the twig.
          7. Ultimate twigs four-sided, the scaly leaves all alike and glandless; fruit berry-like, smooth .... *Juniperus*, p. 706

7. Ultimate twigs flattened, with the scaly leaves of two kinds: those of the lateral row compressed, those of the dorsal and ventral rows flatter, often bearing an oval gland; fruit a woody cone when mature, lumpy when young .... *(Chamaecyparis thyoides)*

6. Leaves spiraled, or sometimes approaching two ranks on the twig.

8. Plant a coniferous tree .... *Taxodium distichum*, p. 706

8. Plant a flowering shrub .... *Tamarix gallica*, p. 736

5. Foliage needle-like or linear.

9. Leaves subulate: rigid, sharp, and spreading (leaves persisting on both twigs and branchlets) ....Immature plants of *Juniperus* and *Chamaecyparis*, called *Retinospora*

9. Leaves not as above.

10. Plant a coniferous tree.

11. Leaves in fascicles of two or three, persistent .... *Pinus*, p. 706

11. Leaves distributed along the deciduous twig .... *Taxodium distichum*, p. 706

10. Plant a flowering shrub.

12. Shrub somewhat aromatic; leaf-scars raised, hence the branchlets rough .... *(Ceratiola ericoides)*

12. Shrub not aromatic; leaf-scars not raised.

13. Leaves alternate.

14. Twigs jointed; a low suffrutescent shrub of sandhills .... *(Polygonella)*

14. Twigs not jointed; a shrub of salt marshes .... *Baccharis angustifolia*, p. 749

13. Leaves opposite or whorled .... *Hypericum*, p. 736

B. LEAVES FROM GROUND.

1. Leaves huge, fan-shaped, deeply incised, not spine-tipped .... *Sabal minor*, p. 707

1. Leaves stiffly linear to spatulate, spine-tipped .... *Yucca*, p. 709

C. LEAVES OPPOSITE, COMPOUND.

1. Stems climbing or twining: vines.

2. Leaflets two .... *Bignonia capreolata*, p. 747

2. Leaflets more than two.

3. Plants climbing by means of aerial rootlets; fruit a long narrow capsule .... *Campsis radicans*, p. 747

3. Plants climbing by means of twining petiolules or tendrils; fruit a hairy or feathery achene .... *Clematis*, p. 719

1. Stems erect: trees or shrubs.

4. Leaves trifoliolate.

5. Leaflets evenly serrulate; fruit a bladdery capsule .... *(Staphylea trifolia)*

5. Leaflets coarsely and irregularly toothed; fruit a samara ....*Acer Negunda*, p. 732

4. Leaves not trifoliolate.

6. Arrangements of leaflets palmate.

7. Leaflets closely serrate; flowers red or yellow; foliage not aromatic .... *Aesculus*, p. 732

7. Leaflets entire or with a few teeth; flowers blue or white; foliage aromatic .... *(Vitex Agnus-castus)*

6. Arrangement of leaflets pinnate.

8. Plant a shrub; twigs with much pith and prominently raised lenticels ....*Sambucus canadensis*, p. 748
8. Plant a tree; twigs with normal pith and inconspicuous lenticels.
  9. The opposite leaf-scars V-shaped, meeting, hence surrounding the twig; leaflets coarsely and irregularly toothed ....*Acer Negundo*, p. 732
  9. The opposite leaf-scars half-oval, not meeting, nor surrounding the twig; leaflets finely and shallowly toothed to entire ....*Fraxinus*, p. 745

D. LEAVES OPPOSITE, SIMPLE.

1. Plants parasitic, evergreen, growing on the limbs of trees ....*Phoradendron flavescens*, p. 718
1. Plants not parasitic, rooted in the ground.
  2. Thorns or prickles present.
    3. Thorns present; twigs and leaves finely pubescent to glabrous ....*Sageretia minutiflora*, p. 733
    3. Thorns absent; twigs and leaves strigose, the twigs prickly ....*Lanana Camara*, p. 747
  2. Thorns or prickles absent.
    4. Plants climbing or twining: vines.
      5. Stems climbing by means of aerial rootlets; some of the blades serrate ....*Decumaria barbara*, p. 721
      5. Stems without aerial rootlets, twining; blades entire.
        6. Plants with milky juice ....*Trachelospermum difforme*, p. 746
        6. Plants without milky juice.
          7. Petiole bases of the opposite leaves connected by a transverse ridge; blades narrowly elliptic to oval or ovate ....*Lonicera*, p. 748
          7. Petiole bases of the opposite leaves not connected; blades lanceolate ....*Gelsemium*, p. 746
    4. Plants not climbing or twining.
      8. Stems creeping, or rising less than 1 meter from stolons or rhizomes, or recurved and rooting.
        9. Leaves white along the veins (leaves persistent, apparently in whorls)...... ....*Chimaphila maculata*, p. 739
        9. Leaves not white along the veins.
          10. Blades under 2 cm. long, cordate; fruit a red berry (plant prostrate, mat-forming) ....*Mitchella repens*, p. 747
          10. Blades over 2 cm. long, not cordate; fruit not a red berry.
            11. Leaves thick and succulent.
              12. Blades mostly entire, the uppermost alternate; heads not radiate; a plant of sandy seashores ....*Iva imbricata*, p. 749
              12. Blades remotely serrate, all opposite; heads radiate; a plant of salt marsh edges ....*Borrichia frutescens*, p. 749
            11. Leaves membranous.
              13. Petiole bases of the opposite leaves meeting or connected by a transverse ridge; stems trailing.
                14. Plant pubescent, at least on the petioles and toward the ends of the twigs; leaves dull; a sprawling vine, not rooting at the nodes ....*Lonicera japonica*, p. 748
                14. Plant glabrous, except sometimes on leaf margins; leaves shining; a trailing subshrub, rooting at the nodes.

15. Leaves glabrous ....(*Vinca minor*)
15. Leaves ciliate ....(*Vinca major*)
13. Petiole bases of the opposite leaves not meeting or connected; stems high-arching, though rooting at the tips (a plant of bogs or swamps) ....*Decodon verticillatus*, p. 738
8. Stems not as above, upright: trees or shrubs.*
16. Margins of blades serrulate, serrate, or dentate throughout their length, sometimes also lobed.
17. Plant a tree.
18. Twigs and petioles bristly-hairy; lenticels conspicuous, orange; sap milky ....*Broussonetia papyrifera*, p. 718
18. Twigs and petioles glabrous or glaucous; lenticels inconspicuous; sap watery ....*Acer*, p. 732
17. Plant a shrub.
19. Blades with three main veins, anastomosing with each other toward the tip (a shrub of salt marsh borders) ....*Iva frutescens*, p. 749
19. Blades with on main vein.
20. Twigs strongly gray-scurfy (leaves tomentose beneath) ....*Callicarpa americana*, p. 747
20. Twigs non-scurfy or red-scurfy.
21. Branchlets and twigs bright green, or the green turning red; petiole bases of the opposite leaves not connected or meeting ....*Euonymus*, p. 732
21. Branchlets and twigs not bright green; petiole bases of the opposite leaves connected by a distinct transverse line, or meeting.
22. Buds at right angles to the twigs, their scales persisting through the following year; bark exfoliating ....(*Hydrangea arborescens*)
22. Buds closer to the twig, their scales not persisting; bark not exfoliating ....*Viburnum*, p. 748
16. Margins of blades entire, at least along the basal half, or if lobed, the margins otherwise smooth.
23. Bases of blades cordate to truncate, from well-developed petioles (plant a tree).
24. Blades conspicously palmately lobed, as broad as long; fruit a samara ....*Acer barbatum*, p. 732
24. Blades usually unlobed, longer than broad; fruit a capsule.
25. Pith continuous; leaves often whorled; capsule long, tubular ....*Catalpa bignonioides*, p. 747
25. Pith chambered or hollow; leaves always opposite; capsule ovate ....(*Paulownia tomentosa*)
23. Bases of blades rounded to attenuate, or else blades sessile.
26. Blades with several anastomosing main veins (plant suffrutescent) ....(*Clematis ochroleuca*)
26. Blades with one main vein, the midrib.
27. Reddish scurf present on lower blade surface, midrib, petiole, or twigs (buds valvate) ....*Viburnum*, p. 748

* Some suffrutescent species are included here.

27. Reddish scurf nowhere present.
  28. Blades punctate (twigs two-angled or two-winged).
    29. Developed sepals two, broad, enveloping the capsule .... *Ascyrum*, p. 735
    29. Developed sepals five, narrow, not enveloping the capsule ....*Hypericum*, p. 736
  28. Blades not punctate.
    30. Leaves whorled, at least some of the nodes with four or five leaves.
      31. Stems terete, usually woolly-tomentose; leaves sessile, their lower surfaces woolly-tomentose .... (*Eriogonum tomentosum*)
      31. Stems deeply channeled and ridged, glabrous; leaves petioled, glabrous ....(*Clerodendron indicum*)
    30. Leaves opposite, or if whorled, the nodes never with more than three leaves.
      32. Foliage persistent.
        33. Leaves crowded toward the ends of the twigs, often whorled; fruit a capsule....*Kalmia*, p. 740
        33. Leaves evenly spaced in pairs throughout the length of the twig; fruit a drupe.
          34. Bases of blades attenuate; margins revolute; twigs glabrous, without conspicuous lenticels ....*Osmanthus americanus*, p. 746
          34. Bases of the blades acute or broadly cuneate to rounded; margins not revolute; twigs not glabrous, or if so, the lenticels conspicuous ....*Ligustrum*, p. 746
      32. Foliage deciduous.
        35. Twigs and leaves spicy-aromatic ....*Calycanthus floridus*, p. 720
        35. Twigs and leaves not spicy-aromatic.
          36. Arrangement of leaves often whorled; fruit a head of nutlets (lateral bud imbedded in the bark) ....*Cephalanthus occidentalis*, p. 747
          36. Arrangement of leaves opposite or sometimes partly alternate; fruit not a head of nutlets.
            37. Leaf-scars connected by a transverse line or ridge.
              38. Petiole bases of the opposite leaves meeting, the stipules lacking; leaves and twigs finely pubescent to glabrous; fruit a drupe ....*Cornus*, p. 738
              38. Petiole bases of the opposite leaves not meeting, but separated by a single large stipule, or its scar, on each side of the twig; leaves and twigs hoary strigose-pubescent; fruit a two-celled, nearly globose capsule ....*Pinckneya pubens*, p. 747

37. Leaf-scars not connected by a transverse line or ridge.
39. Twigs four-winged or four-ridged (upper leaves often alternate; stems with distinctive smooth-sinewy aspect) .... *Lagerstroemia indica*, p. 738
39. Twigs not four-winged or four-ridged.
40. Margins of blades slightly serrate above the middle; blades ovate or ovate-lanceolate .... *(Forestiera acuminata)*
40. Margins of blades entire or slightly undulate, but similar throughout their length; blades mainly oval, elliptic, or oblanceolate.
41. Twigs glabrous .... *Chionanthus virginicus*, p. 745
41. Twigs puberulent to pubescent .... *Ligustrum*, p. 746

E. LEAVES ALTERNATE, COMPOUND.

1. Leaves twice or thrice compound.
2. Stems not erect.
3. Plant prostrate, prickly .... *Schrankia microphylla*, p. 728
3. Plant climbing, not prickly .... *Ampelopsis arborea*, p. 733
2. Stems erect: trees or shrubs.
4. Leaflets with the main vein along the straight upper margin .... *Albizzia Julibrissin*, p. 727
4. Leaflets with the main vein central.
5. Prickles present on primary and secondary rachises of the leaf (as well as on the stem) .... *Aralia spinosa*, p. 738
5. Prickles absent from leaf rachises.
6. Leaflets blunt; stems and twigs often with stout branched thorns .... *Gleditsia*, p. 728
6. Leaflets acuminate; stem and twigs without thorns .... *Melia Azederach*, p. 729
1. Leaves once compound.
7. Leaflets three.
8. Plant with neither stipules nor prickles.
*9. Terminal leaflets broad at base: rounded to obtuse; lateral leaflets not symmetrical; leaflets not punctate; lateral buds visible, buff-colored; fruit a dingy white drupe .... *Rhus*,* p. 729
9. Terminal leaflets tapered at base; lateral leaflets nearly symmetrical; leaflets punctate; lateral buds concealed, imbedded in the bark; fruit a samara .... *(Ptelea trifoliata)*
8. Plant with stipules, or prickles, or both.
10. Stipules adnate to the petiole nearly half its length or more .... *Rosa setigera*, p. 725

* Poisonous to touch.

10. Stipules not adnate to the petiole, or scarcely so.
  11. Chief lateral veins extending straight to the tips of the teeth; stipules persistent; stems biennial .... *Rubus*, p. 725
  11. Chief lateral veins not extending straight to the tips of the teeth; stipules usually deciduous; stems perennial (leaves persistent, shining above; flowers 5-8 cm. across) .... *Rosa laevigata*, p. 725

7. Leaflets more than three.
  12. Leaves palmately compound.
    13. Plant with tendrils, high-climbing; stipules lacking; prickles lacking .... *Parthenocissus quinquefolia*, p. 733
    13. Plant without tendrils, not high-climbing; stipules present; prickles present in most species .... *Rubus*, p. 725
  12. Leaves pinnately compound.
    14. Rachis winged.
      15. Leaves deciduous .... *Rhus copallina*, p. 730
      15. Leaves persistent .... *Sapindus Saponaria*, p. 733
    14. Rachis not winged.
      16. Leaflets entire.
        *17. Petiole and rachis red; fruit a dingy white drupe; sap milky (branchlets mottled tan and brown, with large raised leaf-scars; twigs glabrous, lenticellate; a coarse shrub with branches stout and widely spaced) .... *Rhus vernix*,* p. 730
        17. Petiole and rachis green; fruit not a white drupe; sap not milky.
          18. Stems twining: a vine .... *Wisteria*, p. 728
          18. Stems erect: trees or shrubs.
            19. Leaves persistent; leaflets lanceolate, falcate .... (*Sapindus marginatus*)
            19. Leaves deciduous; leaflets oval or elliptic, nearly symmetrical.
              20. Lateral buds visible; spines and thorns lacking .... *Amorpha*, p. 727
              20. Lateral buds imbedded; spines or thorns often present.
                21. Leaves odd-pinnate, i. e., with a terminal leaflet; stipular spines often present; thorns lacking .... *Robinia*, p. 728
                21. Leaves even-pinnate, i. e., without a terminal leaflet; stipular spines lacking; stout branched thorns often present .... *Gleditsia*, p. 728
      16. Leaflets not entire.
        22. Base of leaflets with a pair of small lobes, each bearing a gland, odiferous if crushed .... *Ailanthus altissima*, p. 729
        22. Base of leaflets not as above.
          23. Pith chambered .... *Juglans nigra*, p. 712
          23. Pith solid.
            24. Leaves regularly even-pinnate, i. e., without a terminal leaflet; stout branched thorns often present .... *Gleditsia*, p. 728
            24. Leaves mostly odd-pinnate, i. e., with a terminal leaflet; branched thorns absent, though prickles sometimes present.

* Poisonous to touch.

25. Prickles present on twigs and often on the petioles and rachises.
26. Lateral leaflets symmetrical; leaflets not glandular-dotted, not stinging to the taste; stipules usually present .... *Rosa*, p. 725
26. Lateral leaflets not symmetrical; leaflets glandular-dotted, stinging to the taste; stipules absent .... *Zanthoxylum Clava-Herculis*, p. 729
25. Prickles absent.
27. Plant a tree; fruit a nut; lateral buds visible; sap not milky .... *Carya*, p. 710
27. Plant a shrub; fruit a red drupe, in terminal clusters; lateral buds imbedded; sap milky .... *(Rhus glabra)*

F. LEAVES ALTERNATE, SIMPLE.

1. Leaves huge, fan-shaped, deeply incised, each segment parallel-veined: palms.
2. Plant without spines; stem upright .... *Sabal Palmetto*, p. 707
2. Plant with spines; stem often prostrate.
3. Spines short, on the petioles .... *(Serenoa repens)*
3. Spines long, on persistent leaf-sheaths .... *(Rhapidophyllum hystrix)*
1. Leaves not as above.
4. Stems not erect: plants climbing, twining, creeping, or matted.
5. Petiole bases, or at least the persistent older ones, provided with a pair of tendrils .... *Smilax*, p. 707
5. Petiole bases without tendrils.
6. Plant prostrate, never climbing; leaves 1.5 cm. long or less.
7. Margins of blades crenate, blunt; plant trailing .... *Vaccinium crassifolium*, p. 743
7. Margins of blades entire, pointed; plant matted ....*(Pyxidanthera barbulata)*
6. Plant usually climbing; leaves mostly over 2 cm.
8. Stem with aerial rootlets (or if trailing, then freely rooting) .... *Hedera Helix*, p. 738
8. Stem without aerial rootlets.
9. Plant a sprawling shrub, the stems not twining and tendrils absent; stems sometimes spiny (blades entire) .... *(Lycium halimifolium)*
9. Plant a true vine, with either stems twining or else tendrils present; stems never spiny.
10. Stems twining; tendrils absent.
11. Leaves with one main vein: pinnate.
12. Blades undulate; lateral veins conspicuously straight .... *Berchemia scandens*, p. 733
12. Blades remotely dentate; lateral veins anastomosing .... *Schisandra glabra*, p. 720
11. Leaves with several main veins: palmate.
13. Petiole attached 2-4 mm. inward from base of blade: leaf slightly peltate; blade nearly glabrous; fruit blue .... *Menispermum canadense*, p. 719
13. Petiole attached at base of blade: leaf not peltate; blade distinctly pubescent; fruit red ......*Cocculus carolinus*, p. 719
10. Stems not twining; tendrils present (or confined to the inflorescence in *Ampelopsis*).

14. Blades entire .... *Brunnichia cirrhosa*, p. 714
14. Blades not entire.
15. Bark of branchlets and older growth shredding; lenticels absent (tendrils branched) .... *Vitis*, p. 734
15. Bark of branchlets and older growth not shredding; lenticels present.
16. Lenticels white, minute, abundant, hence branchlets appearing white-speckled; tendrils frequent along the twigs and branchlets (tendrils unbranched) .... *Vitis rotundifolia*, p. 734
16. Lenticels yellow, prominently raised, few and distant, the branchlets not appearing white-speckled; tendrils mostly confined to the inflorescence .... (*Ampelopsis cordata*)
4. Stems erect: trees or shrubs.
17. Blades lobed.
18. Spines, thorns, or spurs present.
19. Plant suffrutescent, with spines present on leaves and stem; fruit a berry .... *Solanum aculeatissimum*, p. 747
19. Plant a shrub or tree, with thorns or spurs present on twigs or branchlets; fruit a pome.
20. Thorns bearing leaves, leaf-scars, or buds; axillary buds flattened, appressed .... *Malus*, p. 724
20. Thorns smooth, without leaves, leaf-scars, or buds; axillary buds globose, not appressed .... *Crataegus*, p. 723
18. Spines, thorns, or spurs absent.
21. Sap milky.
22. Stipule-scars encircling the twig or practically so .... *Ficus Carica*, p. 718
22. Stipule-scars not encircling the twig.
23. Twigs at first velvety, later becoming hispid toward the ends; visible bud scales two or three; leaf arrangement irregular, often alternate, opposite, and whorled on the same tree .... *Broussonetia papyrifera*, p. 718
23. Twigs glabrous, or at first finely pubescent, later becoming glabrous; visible bud scales three to six; leaf arrangement regularly alternate .... *Morus*, p. 718
21. Sap not milky.
24. Leaves and twigs spicy-aromatic; plant often conspicuous with scattered red leaves, except in spring .... *Sassafras*, p. 721
24. Leaves and twigs not spicy-aromatic; plant without scattered red leaves, at least until autumn.
25. Twigs, buds, and lower leaf surfaces all densely white-tomentose .... *Populus alba*, p. 709
25. Twigs, buds, and lower leaf surfaces not all densely white-tomentose.
26. Blades with one main vein: pinnate.
27. Stipule-scars encircling the twig; buds valvate, not clustered at the end of the twig; blades approximately truncate at both base and apex .... *Liriodendron Tulipifera*, p. 719

27. Stipule-scars not encircling the twig; buds imbricate, clustered at the end of the twig; blades not truncate at both base and apex .... *Quercus*, p. 713

26. Blades with several main veins: palmate.

28. Base of petiole hollow, enveloping the axillary bud; veins of blades tomentose beneath; bark of trunk and branches peeling from large areas, exposing smooth white surfaces .... *Platanus occidentalis*, p. 722

28. Base of petiole not hollow, the axillary bud visible; veins of blades not tomentose beneath; bark not peeling as above.

29. Margins of the lobes evenly crenate-serrate throughout; branchlets often with corky ridges .... *Liquidambar Styraciflua*, p. 722

29. Margins of the lobes not as above; branchlets without corky ridges.

30. Blades very large; margins of the lobes entire, except for an occasional large tooth; bark gray-green, smooth; plant a tree .... *Firmiana platanifolia*, p. 735

30. Blades medium; margins of the lobes coarsely dentate along the upper two-thirds of the blade, entire along the basal third, bark dark, not smooth; plant usually a shrub .... *(Hibiscus syriacus)*

17. Blades not lobed.

31. Veins parallel, or if smaller veins not discernible, the blade over 10 cm. long: plant monocotyledonous.

32. Blades stiff, fleshy, spine-tipped; leaf-sheaths absent .... *Yucca*, p. 709

32. Blades not stiff, fleshy, or spine-tipped; leaf-sheaths present .... *Arundinaria*, p. 707

31. Veins netted, or if smaller veins not discernible, the blade under 10 cm. long: plant dicotyledonous.

33. Plant silvery or bronze, entirely coated with minute stellate scales: a low shrub of beach dunes, with broadly ovate leaves .... *Croton punctatus*, p. 729

33. Plant not as above.

34. Twigs nearly or completely ringed at the nodes.

35. Stems jointed; blades linear to spatulate, under 2 cm. long (plant a low, wiry, suffrutescent shrub).

36. Blades dilated, spatulate .... *(Polygonella polygama)*

36. Blades not dilated, club-shaped to filiform .... *(Polygonella americana)*

35. Stems not jointed, but with stipule-scars nearly or completely encircling the twigs; blades elliptic or broader, over 5 cm. long.

37. Blades entire; stipule-scars completely encircling the twig .... *Magnolia*, p. 719

37. Blades serrate; stipule-scars nearly encircling the twig .... *Fagus grandifolia* var. *caroliniana*, p. 712

34. Twigs not ringed at the nodes.

38. Pith chambered or else divided by thin woody partitions.

39. Twigs and branchlets with chambered pith.
   40. Branchlets and twigs soft, easily crushed or cut by the finger-nail; leaves somewhat sweet to the taste .... *Symplocos tinctoria*, p. 744
   40. Branchlets and twigs normally firm; leaves not sweet to the taste.
      41. Leaves persistent .... *(Leucothoe populifolia)*
      41. Leaves deciduous.
         42. First pair of lateral veins the strongest; bases of the blades usually oblique; bark of trunk often with prominent warts, otherwise smooth, gray .... *Celtis*, p. 717
         42. First pair of lateral veins not the strongest; bases of the blades not oblique; bark of trunk or stems without prominent warts.
            43. Blades entire; lower leaf surfaces pale and marked with darker veins; buds not superposed .... *Diospyros virginiana*, p. 744
            43. Blades serrulate; lower leaf surfaces evenly green; buds often superposed.
               44. Bark of branchlets firm; twigs green; capsules numerous in racemes, not winged .... *Itea virginica*, p. 721
               44. Bark of branchlets often shredding; twigs reddish-brown; capsules solitary or few in clusters, broadly winged...... .... *Halesia*, p. 745
39. Twigs and branchlets with pith not chambered, but divided by thin woody partitions.
   45. Buds, and often twigs, silky with rusty-red hairs.
      46. Blades 10-30 cm. long; pedicels over 1 cm. long, densely hirsute; flowers over 3 cm. wide; plant often a small tree .... *(Asimina triloba)*
      46. Blades 6-17 cm. long; pedicels under 1 cm. long, tomentulose; flowers under 1.5 cm. wide; plant remaining a shrub .... *(Asimina parviflora)*
   45. Buds and twigs glabrous, violet-tinted .... *Nyssa*, p. 739

38. Pith not chambered or divided by thin woody partitions, but solid (or sometimes lacking in *Pavonia*, *Sebastiana*, and *Solanum)*.
   47. Margins of the blades entire. (Second 47 on page 700).
      48. Outline of blade cordate; fruit a legume .... *Cercis canadensis*, p. 728
      48. Outline of blade not cordate; fruit not a legume.
         49. Bases of the blades oblique (blades frequently with three main veins; bark of trunk often with prominent warts, otherwise smooth, gray; fruit an orange drupe) .... *Celtis*, p. 717
         49. Bases of the blades not oblique.
            50. Twigs spicy-aromatic when crushed.
               51. Foliage deciduous, membranous.
                  52. Bark of branchlets green; blades usually

with three main veins, often lobed; drupe blue ....*Sassafras*, p. 721

52. Bark of branchlets light brown to blackish; blades seldom with three main veins, never lobed; drupe red ....*Lindera*, p. 720

51. Foliage persistent, leathery.

53. Leaves and flowers clustered toward the ends of the twigs; fruit dry (plant glabrous) ....*Illicium parviflorum*, p. 719

53. Leaves scattered along the twig, with the flowers in long-peduncled axillary cymes; fruit fleshy, a blue drupe ....*Persea*, p. 721

50. Twigs not spicy-aromatic when crushed.

54. Leaves fleshy, the veins obscure, only the midrib and sometimes a pair of marginal veins visible; plant glabrous (a plant of dunes and salt marshes).

55. Blades narrowly linear, usually only the midrib discernible ....*Baccharis angustifolia*, p. 749

55. Blades oblong-spatulate, usually a pair of marginal veins visible as well as the midrib ....*Iva imbricata*, p. 749

54. Leaves not fleshy, the veins developed, or if somewhat obscure, the plant pubescent.

56. Bases of the blades auriculate-clasping (blades lanceolate; plant a diffusely branched, often a clambering shrub) ....*Aster carolinianus*, p. 748

56. Bases of the blades not auriculate-clasping.

57. Sap milky.

58. Blades elliptic to obovate, their tips acute to rounded.

59. Twigs weak, easily cut or broken; spurs and thorns absent; fruit a three-lobed capsule ....*Sebastiana fruticosa*, p. 729

59. Twigs tough and strong; spurs and often thorns present; fruit a berry-like drupe ....*Bumelia*, p. 744

58. Blades broadly or narrowly ovate, their tips acuminate.

60. Thorns usually present in the leaf-axils; blades narrowly ovate; fruit multiple, globose, fleshy ....*Maclura pomifera*, p. 718

60. Thorns absent; blades very broadly ovate; fruit a cap-

sule with deciduous valves, exposing the persistent white seeds ....*Sapium sebiferum*, p. 729

57. Sap not milky.

61. Blades, or at least their lower surfaces, with minute yellow resinous dots or glands, or else with rusty or silvery scales.

62. Leaves sweet-scented when crushed (fruit a waxy drupe) ......*Myrica*, p. 710

62. Leaves not sweet-scented when crushed.

63. Foliage persistent, bearing rusty or silvery scales on lower leaf surfaces (fruit an ovoid capsule) ....*(Lyonia ferruginea)*

63. Foliage deciduous, bearing yellow resinous dots or glands on lower leaf surfaces.

64. Buds short-conic, extremely divaricate; fruit a persistent urn-shaped capsule ....*Lyonia mariana*, p. 741

64. Buds ovoid, not extremely divaricate; fruit a black or glaucous-blue berry-like drupe ....*Gaylussacia*, p. 739

61. Blades without minute yellow resinous dots or glands, and without scales.

65. Branchlets green, or reddish-tinted, and minutely white-speckled or with a pebbly appearance (fruit a berry) ....*Vaccinium*, p. 742

65. Branchlets not as above.

66. Plant a low, weak shrub, the branchlets, twigs, and leaves conspicuously hirsute, tomentose, or hoary (plant under 1 meter high).

67. Twigs green; fruit a berry ....*Vaccinium*, p. 742

67. Twigs gray or brown; fruit not a berry.

68. Pubescence hirsute; blades ciliate.

69. Blades averaging under 1 cm. long ....*Kalmia hirsuta*, p. 740

69. Blades averaging over 2 cm. long.

70. Plant suffrutescent, the stems weak, without discernible leaf-scars ....*Helianthemum carolinianum*, p. 737

70. Plant woody, the stems stiff, with normally developed leaf-scars ....*Rhododendron*, p. 741

68. Pubescence tomentose or hoary; blades not ciliate.

71. Plant suffrutescent, the stems weak, without discernible leaf-scars; fruit a capsule ....*Helianthemum*, p. 737

71. Plant woody, the stems stiff, with normally developed leaf-scars.

72. Blades linear-elliptic, over 5 cm. long; buds with several scales; fruit an acorn ....*Quercus pumila*, p. 716

72. Blades oblanceolate, under 5 cm. long; buds with a single hood-like scale; fruit a capsule ....*(Salix tristis)*

66. Plant not as above; if low, then less extensively pubescent.

73. Buds clustered at the end of the twig, hence twigs often several from the end of each year's growth of the branchlet.

74. Leaves mostly clustered toward the end of the twig, their margins finely ciliate; fruit a capsule ....*Rhododendron*, p. 741

74. Leaves scattered along the twig, their margins not ciliate; fruit an acorn ....*Quercus*, p. 713

73. Buds not clustered at the end of the twig, nor twigs several from the end of each year's growth of the branchlet.

75. Stipules present, very minute, hard, deltoid to acicular, usually black.
  76. Leaves deciduous, usually sub-opposite; fruit a capsule (plant conspicuous through summer for its handsome flowers) .... *Lagerstroemia indica*, p. 738
  76. Leaves persistent, alternate; fruit berry-like, but actually a drupe containing several small nutlets .... *Ilex*, p. 730
75. Stipules absent or not as above.
  77. Lateral veins curving, becoming parallel to the margins and continuing somewhat toward the tip, not anastomosing...... .... *(Cornus alternifolia)*
  77. Lateral veins not curving and not continuing toward the tip, or else anastomosing near the margin.
    78. Leaf-scars decurrent as ridges, or if obscure, then stipule-scars present.
      79. Twigs sharply triangular in cross-section .... *Lyonia lucida*, p. 741
      79. Twigs terete or squarish in cross-section.
        80. Decurrent ridges paired, arising from the flanks of the leaf-scars; none from the bases of the leaf scars.
          81. Plant an arching or clambering shrub, sometimes vine-like, usually spiny; blades tapering into petioles, the leaves thus spatulate or narrower. .... *(Lycium halimifolium)*
          81. Plant an upright shrub or tree, never spiny; blades nearly sessile, mostly oval .... *Lagerstroemia indica*, p. 738
        80. Decurrent ridges single, arising from the bases of the leaf-scars (sometimes lesser ridges arising from the flanks.)
          82. Stipule-scars present; blades mostly lanceolate, their tips sharply acute to acuminate .... *Prunus caroliniana*, p. 724
          82. Stipule-scars absent; blades mostly oblanceolate, their tips blunt or mucronate .... *Cyrilla racemiflora*, p. 730
    78. Leaf-scars not decurrent; stipule-scars absent.
      83. Hispid hairs present along midrib on lower leaf surface (blades otherwise glabrous; leaves sour to the taste) .... *(Oxydendrum arboreum)*
      83. Hispid hairs lacking along midrib.
        84. Branchlets with short spurs bearing a cluster of leaves at the end; thorns sometimes present on branchlets and twigs .... *Bumelia*, p. 744
        84. Branchlets without spurs; thorns absent.
          85. Leaves persistent.
            86. Blades elliptic, tapering equally at both ends; blades mostly over 5 cm. long...... .... *(Kalmia latifolia)*
            86. Blades oblanceolate to obovate, tapering more at the base than at the apex; blades mostly under 5 cm. long.

87. Twigs and branchlets rigid, wide-spreading; blades broadly obovate with acute bases, from distinct short petioles (plant sometimes a small tree) .... *Vaccinium arboreum*, p. 743

87. Twigs and branchlest not rigid or wide-spreading; blades oblanceolate, with cuneate bases, practically sessile .... (*Kalmia cuneata*)

85. Leaves deciduous.

88. Larger leaves, including petioles, 10 cm. long or more (plant a tree).

89. Petioles grooved; buds rounded; base of trunk swollen; fruit a large elongate drupe .... *Nyssa aquatica*, p. 739

89. Petioles terete; buds acute; base of trunk not swollen; fruit a large globose berry .... *Diospyros virginica*, p. 744

88. Larger leaves, including petioles, under 10 cm. long.

90. Upper surface of the blade very glossy; twigs rigid (blades mostly broadly obovate; fruit a berry; plant sometimes a small tree) .... *Vaccinium arboreum*, p. 743

90. Upper surface of the blade not glossy; twigs flexuous.

91. Branchlets zigzag: repeatedly and widely forking; both twigs and branchlets reddish-brown .... *Litsea aestivalis*, p. 720

91. Branchlets not zigzag; twigs and branchlets green, yellow-brown, or gray.

92. Buds appressed, tapering; blades sometimes minutely serrulate (fruit a globose capsule) .... *Lyonia*, p. 740

92. Buds divergent, conic; blades entire.

93. Twigs green; inflorescence leafy-bracted; fruit a berry .... *Vaccinium*, p. 742

93. Twigs not green; inflorescence not leafy-bracted; fruit a persistent capsule.

94. Capsule globose; blades sometimes very white-glaucous beneath .... *Zenobia pulverulenta*, p. 744

94. Capsule urn-shaped; blades never white-glaucous beneath.... .... *Lyonia mariana*, p. 741

47. Margins of the blades not entire.

95. Plant prickly throughout: on stems, petioles, and blades (plant nearly herbaceous) .... *Solanum aculeatissimum*, p. 747

95. Plant not prickly throughout.

96. Blades white along the veins; stem under 20 cm. high, from rhizomes........ .... *Chimaphila maculata*, p. 739

96. Blades not white along the veins; stems over 20 cm. high.

97. Leaves with yellow resinous glands, especially on lower surface, very sweet-scented when crushed .... *Myrica*, p. 710

97. Leaves without yellow-resinous glands, not sweet-scented when crushed.

98. Sap milky.

99. First pair of lateral veins the largest, originating at the base of the blade.

100. Twigs at first velvety, later becoming hispid toward the ends; visible bud scales two or three; leaf arrangement

irregular, often alternate, opposite and whorled on the same tree .... *Broussonetia papyrifera*, p. 718

100. Twigs glabrous, or at first finely pubescent, later becoming glabrous; visible bud scales three to six; leaf arrangement regularly alternate .... *Morus*, p. 718

99. First pair of lateral veins not the largest, not originating at the base of the blade

101. Blades thin, the margins nearly entire, without glands .... *Sebastiana fruticosa*, p. 729

101. Blades thick, the margins serrulate, with gland-tipped teeth .... *(Stillingia aquatica)*

98. Sap not milky.

102. Leaves thick, fleshy, completely sessile; veins obscure, only the midrib and sometimes a pair of marginal veins visible (a plant of sea beaches) .... *Iva imbricata*, p. 749

102. Leaves not fleshy, nor completely sessile; veins distinct.

103. Twigs and branchlets continuously striate-ridged, and blades long-tapered at base (margins with several prominent broad teeth, nearly lobed) .... *Baccharis*, p. 749

103. Twigs and branchlets not continuously striate-ridged, or if some ridges present, the blades not long-tapered at base.

104. Blades with three main veins: i. e., a pair of lateral veins, distinctly stronger or with more branches than the rest, originating with the midrib at the base of the blade (sometimes additional pairs arising from this point also).

105. Apex of blade rounded (blades glabrous) .... *Ziziphus jujuba*, p. 733

105. Apex of blade acute or acuminate, or if blunt, the lower surface white-tomentose.

106. Margins bluntly toothed: crenate, or with rounded shallow teeth, or with few large rounded teeth .... *Populus*, p. 709

106. Margins sharply toothed: serrate, serrulate, or with numerous point-tipped teeth.

107. Blades with dentate margins: teeth projecting outward; twigs hollow; fruits spiny .... *(Pavonia spinifex)*

107. Blades with serrate or serrulate margins: teeth slanting forward; twigs with pith; fruits not spiny.

108. Plant a weak, much-branched shrub, under 1 meter tall; fruit a capsule .... *Ceanothus*, p. 733

108. Plant a robust shrub or tree, over 1 meter tall; fruit not a capsule.

109. Buds flattened; blades narrowly ovate, to ovate; trunk often with prominent warts, otherwise smooth, gray; fruit an orange drupe, axillary .... *Celtis*, p. 717

109. Buds plump; blades broadly ovate, generally cordate; trunk without warts; fruit a nutlet, the fruits in a cyme with a winged bract attached to the peduncle .... *Tilia*, p. 734

104. Blades with one main vein: i. e., no pair of lateral veins distinctly stronger than the rest, or else such a pair not originating with the midrib at the base of the blade.

110. Thorns present on twigs or branchlets.

111. Leaves, buds or leaf-scars absent from the thorns ....*Crataegus*, p. 723

111. Leaves, buds, or leaf-scars present on the thorns.

112. Margins of the blades regularly serrate or serrulate; reddish glands often present on the upper end of the petioles or the bases of the blades; bud at the end of the twig not truly terminal, a slight point of the twig projecting beyond the base of the bud; fruit a drupe ....*Prunus*, p. 724

112. Margins of the blades irregularly serrate, crenate, or dentate, sometimes nearly lobed; reddish glands absent; bud at the end of the twig truly terminal; fruit a pome ....*Malus*, p. 724

110. Thorns absent.

113. Branchlets green, or reddish-tinted, and minutely white-speckled or with a pebbly appearance (fruit a berry) ....*Vaccinium*, p. 742

113. Branchlets not as above.

114. Buds clustered at the ends of the twigs, hence twigs often several from the end of each year's growth of the branchlet.

115. Leaves mostly clustered toward the end of the twig, their margins finely ciliate; fruit a capsule ..*Rhododendron*, p. 741

115. Leaves scattered along the twig, their margins not ciliate; fruit an acorn ....*Quercus*, p. 713

114. Buds not clustered at the ends of the twigs.

116. Stipules present, very minute, hard, deltoid to acicular, usually black; fruit berry-like, red to black, but actually a drupe containing several small nutlets ....*Ilex*, p. 730

116. Stipules absent or not as above.

117. Margins of the blades irregularly sinuate or with blunt coarse teeth, but without serrations.

118. Plant a tree, the twigs, buds, petioles, and lower surfaces of the blades conspicuously white woolly-tomentose; buds with scales ....*Populus alba*, p. 709

118. Plant a shrub, not white wooly-tomentose, though sometimes with buff scurf or pubescence; buds naked.

119. Buds on well-developed stalks; larger blades over 8 cm. long; flowers with petals, blooming in November or December ....*Hamamelis*, p. 722

119. Buds with indistinct stalks or none; larger blades under 8 cm. long; flowers without petals, blooming in March or April ....*Fothergilla*, p. 721

117. Margins of the blades serrate, serrulate, crenate, or with sharp coarse teeth, if wavy then with serrations also.

120. Leaves persistent.

121. Teeth of the margins prickly; leaf-scars decurrent on the branchlet ....*Prunus caroliniana*, p. 724

121. Teeth of the margins obscure or appressed, not prickly; leaf-scars not decurrent.

122. Buds tapering, naked, silky, not divaricate; flowers solitary in the leaf axils.

123. Blades tapering at base; plant a tree ....*Gordonia Lasianthus*, p. 735

123. Blades acute at base; plant mostly a shrub ....*Camellia sinensis*, p. 735

122. Buds short-conic or globose, scaly, sometimes pubescent but not silky, divaricate; flowers in axillary racemes or leafy-bracted inflorescences.

124. Blades mostly obovate; branchlets rigid; flowers in leafy-bracted inflorescences; fruit a berry ....*Vaccinium arboreum*, p. 743

124. Blades elliptic-lanceolate; branchlets flexuous, arching; flowers in axillary racemes; fruit a capsule ....*Leucothoe axillaris*, p. 740

120. Leaves deciduous.

125. Twigs broadened at each node in the plane of the petiole; buds superposed ......*Styrax*, p. 745

125. Twigs not broadened at each node in the plane of the petiole; buds not superposed.

126. Margins of the blades entire except for a few very large, angulate, mucro-tipped teeth ....*Nyssa aquatica*, p. 739

126. Margins of the blades not as above.

127. Blades linear-lanceolate; buds with a single, hood-like scale; twigs breaking rather easily from the branchlets ....*Salix*, p. 709

127. Blades broader than linear-lanceolate; buds with more than one scale, unless naked; twigs not breaking easily from the branchlets.

128. Lateral veins unbranched to the margin, there curving forward until nearly joined in a marginal sequence (blades oblong-elliptic, very shallowly and obscurely serrate; buds naked; fruit a black berry-like drupe with several nutlets) ....*Rhamnus caroliniana*, p. 733

128. Lateral veins branching, or if unbranched, then not curving forward at the margin, but proceeding into the teeth.

129. Blades with lateral veins conspicuously straight, each terminating in the tip of a tooth (if branched, the original vein continuing straight, the branches diverging).

130. Margins of the blades coarsely and singly serrate, every tooth reached by an unbranched lateral vein; fruit (a nut) enclosed in a spiny bur ....*Castanea*, p. 712

130. Margins of the blades closely or doubly serrate or serrulate, every tooth not reached by an unbranched lateral vein; fruit not enclosed in a spiny bur.

131. Bases of the blades oblique, and one longitudinal half of the blade broader than the other, at least in the basal portion.

132. Bark furrowed; margins of the blades mostly doubly-serrate; fruit a samara (twigs sometimes corky-winged) ....*Ulmus*, p. 717

132. Bark close, rather smooth; margins of the blades mostly singly serrate; fruit nut-like .... *Planera aquatica*, p. 717

131. Bases of the blades not or scarcely oblique, and both longitudinal halves of the blade essentially equal.

133. Buds stalked .... *Alnus serrulata*, p. 713

133. Buds not stalked.

134. Bases of the blades acute; margins not closely and sharply serrulate or serrate, but more irregular, sometimes crenate or dentate; lateral buds flattened; fruit a pome .... *Malus*, p. 724

134. Bases of the blades broad, rounded, or cordate; margins closely and sharply serrulate, serrate, or doubly serrate; lateral buds terete or four-sided; fruit not a pome.

135. Buds four-sided; trunk sinewy-fluted, with smooth dark bark; fruit a nutlet attached to a three-lobed leafy bract .... *Carpinus caroliniana*, p. 702

135. Buds terete; trunk not sinewy-fluted, with rough, flaky, or light-colored bark; fruit not as above.

136. Bases of the blades truncate or forming a broad angle; branchlets often with short spurs; bark breaking into large woody plates or very broad papery layers; fruit a samara, in cone-like catkins .... *Betula nigra*, p. 712

136. Bases of the blades cordate or rounded; branchlets without short spurs; bark and fruit not as above.

137. Outlines of the serrate margins even; bases of the blades generally rounded; bark flaking in numerous rectangular plates; fruit a nutlet enclosed in an inflated bag .... *(Ostrya virginiana)*

137. Outlines of the serrate margins uneven; somewhat wavy; bases of the blades generally cordate; bark not flaking in numerous rectangular plates; fruit a nut attached to two open ragged bracts .... *Corylus americana*, p. 712

129. Blades with lateral veins anastomosing irregularly near the margin, the veinlets, only, reaching the tips of the teeth, or the tips not reached.

138. Upper surface of blade with appressed black whisker-like glands along the midrib (fruit a berry-like pome) .... *Aronia*, p. 722

138. Upper surface of blade without black whisker-like glands along midrib.

139. Small warty glands present near the upper end of the petiole or at the base of the blade (a dense row of light-colored hairs present on either side of the midrib toward base of lower leaf surface in *Prunus serotina;* buds woolly, often collateral, in *P. Persica*) .... *Prunus*, p. 724

139. Small warty glands absent from petiole or base of blade.

140. Spurs present on the branchlets.

141. Bud at the end of the twig truly terminal; fruit a globose or pear-shaped pome.

142. Axillary buds mostly appressed pubescent; margins of the blades often irregularly serrate, crenate, or dentate; pome globose .... *Malus*, p. 724

142. Axillary buds not appressed, glabrous; margins of the blades regularly and finely appressed serrate or crenate; pome pyriform: a pear .... *Pyrus communis*, p. 725

141. Bud at the end of the twig pseudo-terminal, a slight point of the twig projecting beyond the base of the bud; fruit a drupe .... *Prunus*, p. 724

140. Spurs absent.

143. Twigs scurfy with gray stellate pubescence; fruit a .... *Clethra*, p. 739

143. Twigs glabrous, or if with pubescence, this not scurfy or stellate; fruit not a three-valved capsule.

144. Bases of the blades oblique, and one longitudinal half of the blade broader than the other, at least in the basal portion .... *Planera aquatica*, p. 717

144. Bases of the blades not oblique, and both longitudinal halves of the blade essentially equal.

145. Outline of blade deltoid, the base mostly truncate .. *Populus deltoides* var. *missouriensis*, p. 709

145. Outline of the blade ovate, elliptic, oval, or obovate, the base not truncate.

146. Hispid hairs present along midrib on lower surface of blade, which is otherwise glabrous; leaves sour to the taste .... *(Oxydendrum arboreum)*

146. Hispid hairs absent, or if midrib with pubescence, this soft and not distinct from that of the rest of the blade; leaves not sour to the taste.

147. Buds silky; branches sometimes arching and rooting at the tips .... *Stewartia Malachodendron*, p. 735

147. Buds glabrous or merely ciliate; branches not rooting at the tips.

148. Bases of blades mostly rounded, or some of them cordate or acute; petioles averaging 1 cm long or more; leaf-scars bearing three bundle-scars; fruit a berry-like pome .... *Amelanchier*, p. 722

148. Bases of blades mostly acute; petioles averaging under 1 cm. long; leaf-scars bearing a single bundle-scar; fruit a capsule or a true berry.

149. Upper surface of the blade very glossy; twigs rigid; fruit a shining black berry (blades broadly obovate) ...... *Vaccinium arboreum*, p. 743

149. Upper surface of the blade not glossy; twigs flexuous; fruit a rather persistent capsule.

150. Buds slender, appressed; inflorescence a panicle, often leafy-bracted .... *Lyonia*, p. 740

150. Buds short-conic, divaricate; inflorescence not a panicle, not leafy-bracted.

151. Margins regularly serrulate; flowers and capsules in racemes, the pedicels under 5 mm. long; leaves never glaucous .... *Leucothoe racemosa*, p. 740

151. Margins irregularly or obscurely serrulate; flowers and capsules in clusters along the branchlets, the pedicels over 10 mm. long; leaves sometimes glaucous .... *Zenobia pulverulenta*, p. 744

Catalogue with Keys to the Species

Pinaceae (Pine Family)

JUNIPERUS. Redcedar.

1. Fruits ovoid, 3-5 mm. long .... *J. silicicola*
1. Fruits subglobose, 5-6 mm. long .... *(J. virginiana)*

§ J. SILICICOLA (Small) Bailey. *Sabina silicicola* Small. Southern Redcedar.—Frequent along salt marsh borders and shore woods. Often mistaken by collectors for *J. virginiana* L., familiar inland and northward, and for *J. barbadensis* Sarg., of the West Indies.

PINUS. Pine.

1. Twigs 1.5-2.5 cm. thick, including the persistent covering of close-set blackish bracts; cones over 15 cm. long (cones not reflexed; needles 3 in a fascicle) .... *P. palustris*
1. Twigs less than 1.5 cm. thick, not including the bracts which are deciduous or too sparse to cover the twig; cones under 15 cm. long.
   2. Needles short, all under 13 cm. long (cones ovoid).
      3. Bark flaky; needles yellow-green, stout, only slightly twisted .... *P. echinata*
      3. Bark solid, in close-fitting rectangular blocks on the trunk, smooth on the branches; needles glaucous, slender, much twisted .... *P. glabra*
   2. Needles mostly over 13 cm. long.
      4. Opened cones short, globose, about 6 cm. in diameter, or broader than long; tufts of leafy twigs usually sprouting from trunk .... *P. serotina*
      4. Opened cones ovoid to cylindric, over 6 cm. long; trunk normally without tufts of twigs.
         5. Needles 2 or 3 in a fascicle on the same tree, dark green; cones reflexed on short curved stalks .... *P. caribaea*
         5. Needles 3 in a fascicle, light green; cones sessile .... *P. Taeda*

§ P. CARIBAEA Morelet. *P. Elliottii* Engel. *P. palustris* as given in Small's *Manual*. Slash Pine.—Native in our area only on the sea islands (frequent on Folly Island), but now being extensively planted.

§ P. ECHINATA Mill. Shortleaf Pine.—Frequent in dry sandy woods and the drier pine woods.

§ P. GLABRA Walt. Spruce Pine.—Frequent in moist rich woods.

§ P. PALUSTRIS Mill. *P. australis* Michx. f. Longleaf Pine.—Locally abundant in pine woods, dry sandy woods, and old fields; also extensively planted. Occasional in bays where fires have driven out the other species.

× P. SONDEREGGERI H. H. Chapm. might be sought in our area, a hybrid of *P. palustris* and *P. Taeda*.

§ P. SEROTINA Michx. *P. rigida* Mill. var. *serotina* (Michx.) Loud. Pond Pine.—Frequent in bays and poorer pine woods.

§ P. TAEDA L. Loblolly Pine.—Common and abundant nearly everywhere.

TAXODIUM. Baldcypress.

§ T. DISTICHUM (L.) Rich. Baldcypress.—Common in wet woods and cypress swamps.

This passes indistinguishably into a smaller-leaved form (pondcypress) which has been recognized as *T. ascendens* Brongn. and *T. distichum* (L.) Rich. var. *imbricarium* (Nutt.) Sudw. The extremes of the two forms may be separated as follows:

1. Leaves developed, linear, two-ranked, spreading from the deciduous twig; these twigs spreading from the branchlets .... *T. distichum*
1. Leaves tiny, acicular, appressed all around the deciduous twig; these twigs ascendant from the branchlets .... *T. ascendens*

Gramineae (Grass Family)

ARUNDINARIA. Cane.

1. Inflorescences borne on short leafless radical shoots of the year (plants not over 4 m. tall) .... *A. tecta*

1. Inflorescence borne on leafy branches of the old canes (plants may be up to 10 m. tall) .... *(A. gigantea)*

§ A. TECTA (Walt.) Muhl. Small Cane. — Common in wet woods and bays.

It is very possible that the Large Cane (*A. gigantea* (Walt.) Chapm.) is also in our area, but I have not yet observed the infrequently-produced axillary inflorescences that would prove its identity.

Palmaceae (Palm Family)

SABAL. Palmetto.

1. Blade arched downward; center rib strong, a continuous structural axis; blade not splitting into two parts; plant soon caulescent .... *S. Palmetto*

1. Blade stiffly spread, not arched downward; center rib lacking or weak, not a continuous structural axis; blade splitting with age into two parts; plant acaulescent in our area .... *S. minor*

§ S. MINOR (Jacq.) Pers. *S. glabra* (Mill.) Sarg. Dwarf Palmetto. — Common in wet woods, along stream banks and salt marsh borders; frequent elsewhere.

§ S. PALMETTO (Walt.) Lodd. Cabbage Palmetto. — Common in shore woods; surviving on the beaches after other woody species have succumbed.

Liliaceae (Lily Family)

SMILAX. Greenbrier, Chanybrier.

The interpretation here generally follows that presented by W. C. Coker in *The woody Smilaxes of the United States*, Jour. Elisha Mitchell Soc. **60**:27-69, 1944.

1. Plants trailing, pubescent, with pointed ovoid berries (berries varying shades of orange) .... *S. pumila*

1. Plants climbing, glabrous or glaucous, with usually globose berries.
   2. Leaves conspicuously glaucous beneath .... *S. glauca*
   2. Leaves glabrous and green on both surfaces.
      3. Twigs of the year not subtended by leaves of the previous year: leaves deciduous, though often tardily so.
         4. Leaf margins closely roughened, like the edge of a file; outlines often pandurate, i. e., fiddle-shaped; spines weak, thin, black, mostly toward base of stems (berries black) .... *S. hispida* var. *australis*
         4. Leaf margins smooth, remotely roughened, or prickly; outlines sometimes hastate but not pandurate; spines stout if present.
            5. Leaf outlines without a concave curve below the apex; mature blades orbicular, ovate, or lanceolate; spines never actually on the nodes; berries usually with 2 or 3 seeds.
               6. Tips of leaves short-acuminate, i. e., apex flanks slightly concave; leaf margins often remotely roughened; berries glaucous, black .... *S. rotundifolia*
               6. Tips of leaves acute, i. e., apex flanks straight or slightly convex, excepting the mucronate extension; leaf margins always smooth; berries bright red .... *S. Walteri*
            5. Leaf outlines with a concave curve near the base or middle, or sometimes flattened, not completely convex on all of the leaves; mature blades

often hastate; spines present on the nodes as well as in the internodes; berries usually with a single seed (berry black) ....*S. Bona-nox*

3. Twigs of the year subtended by leaves of the previous year: leaves persistent.
   7. Leaves thin, the blades lanceolate to ovate, tapering, with the apex acute to acuminate; stems without spines, unless sparsely present below; youngest branchlets straight (berries maroon, ripening to black) ....*S. lanceolata*
   7. Leaves thick, the blades elliptic or various, the rounded end abruptly tipped with a cusp or mucro; stems more spiny; youngest branchlets slightly to strongly zigzag.
      8. Blades generally elliptic, with 3 veins; margins entire; branchlets only slightly zigzag; berries with one seed (berries black) ....*S. laurifolia*
      8. Blades various, often broadened near the base, with 5 veins, or 3 if the blade is linear; margins slightly undulate (never prickly); branchlets usually strongly zigzag; the larger of the berries with 2 or 3 seeds (berries purplish, ripening to black) ....*S. auriculata*

§ S. AURICULATA Walt. *S. Beyrichii* Kunth. Wild-bamboo. — Common on beaches, salt marsh borders, and in shore woods; frequent in old fields, pine woods, and bays.

§ S. BONA-NOX. Sawbrier, Chinabrier. — Common nearly everywhere, although *S. auriculata* surpasses it at the shore and *S. glauca* is more abundant in the pine woods.

Coker has described our coastal form as *S. Bona-nox* L. var. *littoralis*, which he distinguishes from typical *S. Bona-nox* as it occurs inland:

1. Stems harshly scurfy at lower part; tubers spiny ....*S. Bona-nox* L.
1. Stems smooth, not scurfy; tubers not spiny ....*S. Bona-nox* L. var. *littoralis* Coker

Fernald, on the other hand, in his discussion of *Smilax* in Rhodora **46**:32-42, 1944, recognizes four kinds under *S. Bona-nox*, which may be separated as follows:

1. Blades of mature growth with smooth margins ....*S. Bona-nox* L. var. *hederaefolia* (Beyr.) Fern.
1. Blades of mature growth, as well as of shoots, with bristly-ciliate margins.
   2. Basal lobes lacking, the blades oblong-lancolate with nearly parallel sides ....*S. Bona-nox* L. var. *exauriculata* Fern.
   2. Basal lobes present, or at least the blades broadest at the base.
      3. Blades deltoid with short rounded basal lobes, tapering into the upper part of the blade ....*S. Bona-nox* L.
      3. Blades narrowly lanceolate with abruptly divergent narrow basal lobes ....*S. Bona-nox* L. var. *hastata* (Willd.) A. DC.

Under this interpretation, typical *S. Bona-nox* and the variety *hederaefolia* are both common here, the variety *hastata* is occasional, and no specimens of the variety *exauriculata* have been found within our radius. Intermediate cases are often encountered.

§ S. GLAUCA Walt. Sawbrier. — Common in old fields, pinelands, bays, and wet woods; frequent elsewhere.

§ S. HISPIDA Muhl. var. AUSTRALIS Norton in Small. Greenbrier. — Common in wet woods; frequent in moist rich woods and along streams.

Fernald reports in Rhodora **46**:38-39, 1944, that the name *S. tamnoides* L. properly applies to this plant.

§ S. LANCEOLATA L. Southern Smilax. — Common in moist rich woods; frequent elsewhere.

According to Fernald, in Rhodora **46**:39-42, 1944, this plant should be known as *S. Smallii* Morong.

§ S. LAURIFOLIA L. Bamboo-vine. — Common in bays and seepage slopes; frequent in wet woods.

§ S. PUMILA Walt. Sarsaparilla-vine. — Common in dry sandy woods; frequent in pinelands and moist rich woods.

§ S. ROTUNDIFOLIA L. Greenbrier. — Common in wet woods, cypress swamps, and along stream-banks; frequent in moist rich woods.

§ S. WALTERI Pursh. Coral Greenbrier. — Common in cypress swamps; frequent in wet woods; occasional in bays and along streams.

YUCCA. Yucca, Spanish Bayonet.

1. Leaves mostly pliant and rather plicate, with marginal curly threads; plants acaulescent or short-stemmed; fruit a dehiscent capsule.
   2. Blades linear-lanceolate, attenuate to the slender spine .... *Y. Smalliana*
   2. Blades spatulate, more abruptly narrowed or rounded to the stout spine.... .... *Y. filamentosa*
1. Leaves stiff, without marginal curly threads except sometimes in the oldest leaves; stems of mature plants over 1 m. high; fruit indehiscent.
   3. Blades scabrous at the edge, the lower surface smooth; fruit pulpy; seeds thin, margined .... *Y. aloifolia*
   3. Blades smooth at the edge, except for a few teeth when young, the lower surface rough; fruit leathery; seeds turgid, without margins .... *Y. gloriosa*

§ Y. ALOIFOLIA L. Aloe Yucca, Spanish Dagger. — Frequent at beach dunes, salt marsh borders, and shore woods.

§ Y. FILAMENTOSA L. *Y. concava* Haw. *Y. filamentosa* L. var. *concava* (Haw.) Bak. Spoon-leaf Yucca. — Frequent at beach dunes, salt marsh borders, shore woods, and sandy fields. An inland occurrence of interest is at the Michaux Garden.

§ Y. GLORIOSA L. Moundlily Yucca. — Occasional at beach dunes and salt marsh borders.

§ Y. SMALLIANA Fern. *Y. filamentosa* of authors. Adams Needle. — Occasional at salt marsh borders and old fields near the shore.

See Fernald in Rhodora **46**:5, 1944, for a discussion of the nomenclature of this species and of *Y. filamentosa* L.

Varieties of this species were described by Engelmann on the basis of Dr. Mellichamp's collections at Bluffton, but they do not seem suffiicently distinct.

Salicaceae (Willow Family)

POPULUS. Poplar.

1. Blades white-tomentose beneath, lobed or coarsely few-toothed .... *P. alba*
1. Blades not white-tomentose when mature, crenate-serrate.
   2. Petioles flattened .... *P. deltoides* var. *missouriensis*
   2. Petioles terete .... *P. heterophylla*

§ P. ALBA L. White Poplar.— Occasional in old fields: an escape from cultivation.

§ P. DELTOIDES Marsh. var. MISSOURIENSIS Henry. Southern Poplar, Carolina Poplar. — Occasional in wet woods; also widely escaped from cultivation along roads and in old fields.

§ P. HETEROPHYLLA L. Swamp Cottonwood. — Frequent in cypress swamps and wet woods.

SALIX. Willow.

1. Plant a low shrub, under 1 m. tall; blades oblanceolate, gray-tomentose beneath .... (*S. tristis*)
1. Plant a large shrub or tree; blades lanceolate, green or white beneath.
   2. Blades white beneath, glaucous or finely pubescent.
      3. Twigs brittle at base, breaking off from the branch if lightly struck .... *S. Harbisoni*
      3. Twigs scarcely brittle at base, not breaking off unless pulled ....*S. caroliniana*

2. Blades green beneath, glabrous or nearly so (twigs brittle at base) .... *S. nigra*

§ S. CAROLINIANA Michx. *S. longipes* Shuttlew. *S. longipes* Shuttlew. var. *venulosa* (Anders.) Schneid. *S. longipes* Shuttlew. var. *Wardii* (Bebb) Schneid. Coastal-Plain Willow. — Collected at Windermere, as *S. longipes* Shuttlew.; Navy Yard, *Robinson* (G), as *S. nigra* Marsh.; Isle of Palms, *Ball* (G), as *S. Wardii* Bebb; Isle of Palms, *Harbison* (AA), as *S. longipes* Shuttlew. var. *venulosa* (Anders.) Schneid.

The tangled nomenclature of this species and its variety *Wardii* is discussed by Fernald in Rhodora **48**:28-31, 1946.

§ S. HARBISONI Schneid. Harbison Willow. — Common along streams, ditches, and fresh marsh borders, and in wet woods and cypress swamps.

C. R. Ball now regards this as a variety of *S. caroliniana* Michx. (*S. longipes* Shuttlew.).

§ S. NIGRA Marsh. Black Willow. — Occasional in cypress swamps and wet woods.

Myricaceae (Bayberry Family)

MYRICA. Myrtle.

1. Shrubs under 1 m. tall, with underground stems .... *M. pusilla*
1. Shrubs or trees over 1 m. tall, without underground stems.
   2. Blades thin, oblanceolate; bases long-attenuate; fruits 2-3 mm. through .... *M. cerifera*
   2. Blades thick, elliptic or obovate to oblanceolate; bases cuneate; fruits 3-5 mm. through.
      3. Branchlets pubescent; leaves pubescent when young .... *M. heterophylla*
      3. Branchlets glabrous; leaves glabrous .... *M. heterophylla* var. *Curtissi*

§ M. CERIFERA L. *Cerothamnus ceriferus* (L.) Small. Southern Waxmyrtle, Myrtle. — Common or frequent in all habitats except the cypress swamp.

§ M. HETEROPHYLLA Raf. *M. carolinensis* Mill. *Cerothamnus carolinensis* (Mill.) Tidestrom. Bayberry, Myrtle. — Frequent in moist pinelands and on seepage slopes.

§ M. HETEROPHYLLA Raf. var. CURTISSI (Chev.) Fern. *M. carolinensis* Mill. *Cerothamnus carolinensis* (Mill.) Tidestrom. Bayberry, Myrtle. — Occasional in bays.

§ M. PUSILLA Raf. *M. cerifera* L. var. *pumila* Michx. *Cerothamnus pumilus* (Michx.) Small. Dwarf Waxmyrtle. — Common in pine woods.

Juglandaceae (Walnut Family)

CARYA. Hickory.

1. Bud scale imbricate; husk not winged.
   2. Petiole and rachis glabrous.
      3. Bark close-furrowed; husk splitting only in upper portion; outer bud scales persistent.
         4. Fruit, including husk, about 2.5 cm. long, 2 cm. wide .... *C. glabra*.
         4. Fruit, including husk, 3-5 cm. long, about 3 cm. wide .... *C. glabra* var. *megacarpa*
      3. Bark ridged, separating into plates; husk splitting finally to the base; outer bud scales deciduous.
         5. Plates of bark small, 2 or 3 cm. long; husk thin, under 4 mm. .... (*C. ovalis*)
         5. Plates of bark large, 15-50 cm. long; husks thick, 4 mm. or more .... (*C. ovata*)
   2. Petiole and rachis tomentose (sometimes nearly glabrous in *C. pallida*).
      6. Bark shaggy, separating into long plates .... (*C. ovata*)
      6. Bark rough but not separating into long plates.

7. Leaves yellow-green below; terminal leaflets nearly half as wide as long; shell 4-angled.

8. Terminal buds all under 2 cm. long (excepting sucker shoot growth) .... *C. tomentosa*

8. Terminal buds often over 2 cm. long (leaflets larger, thicker, more heavily pubescent; shells larger, more prominently angled, with extremely thick husks) .... (*C. tomentosa* var. *subcoriacea*)

7. Leaves whitish-green below; terminal leaflets mostly one-third as wide as long; shell rounded .... (*C. pallida*)

1. Bud scales valvate; husk with winged sutures.

9. Leaflets not or scarcely falcate, ovate-lanceolate, 5-9, occasionally 11.

10. Buds silvery or golden; shell scarcely longer than broad.

11. Leaflets silvery-white to bronze below, due to a coating of peltate scales; buds silvery; husk 4-ridged to the base .... *C. myristicaeformis*

11. Leaflets finely pubescent below; buds golden; husk 4-ridged, but not to the base.

12. Width of leaflets under 5 cm. .... *C. cordiformis*

12. Width of leaflets over 5 cm. .... *C. cordiformis* var. *latifolia*

10. Buds brown; shell elongate .... *C. illinoensis*

9. Leaflets usually falcate, lanceolate, 11-13, occasionally 9.

13. Serrations of leaflets very shallow, inconspicuous; shell flattened, not elongate; a tree of wet woods and stream banks .... *C. aquatica*

13. Serrations of leaflets more prominent; shell terete, elongate; a tree escaped from cultivation. .... *C. illinoensis*

§ C. AQUATICA (Michx. f.) Nutt. *Hicoria aquatica* (Michx. f.) Britton. Water Hickory. — Frequent in wet woods and along stream banks; occasional in cypress swamps and moist rich woods.

§ C. CORDIFORMIS (Wang.) K. Koch. *Hicoria cordiformis* (Wang.) Britton. Bitternut Hickory. — Frequent in moist rich woods and occasional in pine woods.

§ C. CORDIFORMIS (Wang.) K. Koch var. LATIFOLIA Sarg. *Hicoria cordiformis latifolia* (Sarg.) Ashe. Broadleaf bitternut hickory. — Collected 0.5 miles south of Warren's Crossroads in rich woods above a stream, *Duncan* and *Hunt*.

§ C. GLABRA (Mill.) Sweet. *Hicoria glabra* (Mill.) Britton. Pignut Hickory. — Collected in dry sandy woods on Willow Hall Rd., 1.2 miles east of Rt. 511. This, the only collection with fruit measuring within the limits of *C. glabra* (as distinguished from the variety *megacarpa*), seems to be the form which Ashe further distinguished as *Hicoria glabra* (Mill.) Britton var. *reniformis* (Charleston Mus. Quart. **1**(2): 29. 1925).

§ C. GLABRA (Mill.) Sweet var. MEGACARPA (Sarg.) Sarg. *Hicoria glabra* (Mill.) Britton var. *megacarpa* (Sarg.) Sudworth. Coast Pignut Hickory. — Common in moist rich woods; frequent in dry sandy woods, pine woods, and along stream banks.

C. MYRISTICAEFORMIS (Michx. f.) Nutt. *Hicoria myristicaeformis* (Michx. f.) Britton. Nutmeg Hickory. — Collected in moist rich woods in Daisy Swamp near Rt. 2; "swamps of Cooper River," *Ravenel* (M); reported by *F. A. Michaux* from Izard's plantation on upper Goose Creek.

§ C. ILLINOENSIS (Wang.) K. Koch. *C. Pecan* (Marsh.) Engl. & Graebn. *Hicoria Pecan* (Marsh.) Britton. Pecan. — In our area only as an escape from cultivation.

The necessity for abandoning the familiar name of *C. Pecan* is explained by Rehder in Jour. Arn. Arb. **22**:571-572, 1941.

§ C. TOMENTOSA (Lam.) Nutt. *C. alba* (L.) K. Koch. *Hicoria alba* (L.) Britton. Mockernut Hickory. — Common in dry sandy woods; frequent in pinewoods and moist rich woods.

The thicker-leaved variety, *C. tomentosa* (Lam.) Nutt. var. *subcoriacea* (Sarg.) Palm. & Steyerm., is in all probability here also, but collections have not yet been made.

JUGLANS. Walnut.

§ J. NIGRA L. *Wallia nigra* (L.) Alef. Black Walnut. — Frequent in wet woods and moist rich woods; occasional in dry sandy woods and along stream banks.

Betulaceae (Birch Family)

ALNUS. Alder.

§ A. SERRULATA (Ait.) Willd. *A. rugosa* of authors. Alder. — Confined in our area to seepage slopes, but common there.

The reasons for adopting Aiton's name are cited by Fernald in Rhodora **47**:337-343, 1945.

BETULA. Birch.

§ B. NIGRA L. River Birch. — Frequent along stream banks; occasional in moist rich woods and wet woods.

CARPINUS. Hornbeam.

§ C. CAROLINIANA Walt. American Hornbeam, Carolina Bluebeach. — Common in moist rich woods, wet woods, and along stream banks.

CORYLUS. Hazelnut.

§ C. AMERICANA Walt. American Hazelnut. — Collected in rich sloping woods at Slann's Bridge, upper Ashley River; in rich sloping woods 0.5 mile south of Cooke's Crossroads on Delemar Rd., *Duncan* and *Hunt;* at Michaux Garden, *Horlbeck, Hunt, Slocum, Williams.*

Fagaceae (Beech Family)

CASTANEA. Chinquapin.

1. Plant a low shrub with erect branches from horizontal underground stems .... *C. alnifolia*
1. Plant a tree or shrub without underground stems.
    2. Blades all finely tomentose beneath.
        3. Leaves thin to firm; spines of the bur slender, 7-10 mm. long, close set, usually concealing the surface of the bur ....(*C. pumila*)
        3. Leaves firm to subcoriaceous; spines of the bur stout, 5-8 mm. long, spreading and scattered, not completely concealing the surface of the bur .... *C. pumila* var. *Ashei*
    2. Blades of lower growth glabrous or glabrate beneath, only those of the faster growing shoots tomentose .... *C. alnifolia* var. *floridana*

§ C. ALNIFOLIA Nutt. *C. nana* Muhl. Dwarf Chinquapin. — Collected in dry sandy woods subject to fire, 1.5 miles north of Ravenel; from "Summerville, S. C.," (G); reported at Wampee, Martin's Point Rd., Wadmalaw Island, *Mrs. F. H. Horlbeck.*

§ C. ALNIFOLIA Nutt. var. FLORIDANA Sarg. *C. floridana* (Sarg.) Ashe. Florida Chinquapin. — Occasional in pine woods, dry sandy woods, and moist rich woods.

§ C. PUMILA (L.) Mill. var. ASHEI Sudw. *C. Ashei.* Ashe Chinquapin.— Common in dry sandy woods; frequent in moist rich woods, pine woods, and old fields.

Numerous collections from our area have been labeled *C. pumila* (L.) Mill., but in all cases they seem to conform to *C. pumila* var. *Ashei.*

FAGUS. Beech.

§ F. GRANDIFOLIA Ehrh. var. CAROLINIANA (Loud.) Fern. & Rehd. American Beech. — Confined to moist rich woods; common there.

*QUERCUS. Oak.

1. Low shrubs with horizontal underground stems.
   2. Blades lobed or strongly undulate .... *Q. stellata* var. *Margaretta*
   2. Blades entire, crisped, or revolute.
      3. Leaf apex bristle-tipped; the mature shrubs much-branched, fruiting .... *Q. pumila*
      3. Leaf apex not bristle-tipped; growth merely shoots from stolons of trees, not fruiting .... Proceed to 11, *Q. virginiana* and vars.
1. Trees or shrubs without underground stems.
   4. Blades broadest close to the end.
      5. Leaves mostly over 6 cm. broad, yellowish beneath.
         6. Pubescence beneath a dull gray-yellow; petioles slender, usually over 1.5 cm. long; bark shallowly fissured into ridges .... *Q. falcata*
         6. Pubescence beneath a bright orange-yellow; petioles stout, usually under 1.5 cm. long; bark deeply divided into blocks .... *Q. marilandica*
      5. Leaves mostly under 6 cm. broad, green beneath.
         7. Margins conspicuously revolute; blades abruptly narrowed or rounded at base; twigs tomentose or dull .... (*Q. myrtifolia*)
         7. Margins scarcely revolute; blades gradually tapered to the cuneate base; twigs glabrous and shiny .... *Q. nigra*
   4. Blades broadest nearer to the middle than the end.
      8. Acorn maturing in the first year, its shell glabrous within; leaves not bristle-tipped: *white oaks*.
         9. Leaves persistent or nearly so; blades entire or undulate (except sometimes on shoots).
            10. Margins flat and undulate, or occasionally with shallow rounded lobes; acorns sessile .... (*Q. Chapmani*)
            10. Margins revolute, or if flat then the blades entire or with a few sharp-pointed lobes but not undulate; acorns stalked (except in *Q. myrtifolia*).
               11. Blades elliptic to obovate, entire or sometimes undulate.
                  12. Lower leaf surface with permanent tomentum; blades generally elliptic, mostly over twice as long as wide; acorns stalked.
                     13. Leaves slightly or moderately revolute, finely tomentose, with veins slightly projecting beneath .... *Q. virginiana*
                     13. Leaves extremely revolute, heavily tomentose, with veins conspicuously projecting beneath .... *Q. virginiana* var. *geminata*
                  12. Lower leaf surface glabrous or with loose tomentum easily rubbed off; blades generally short-obovate, less than twice as long as wide; acorns sessile .... (*Q. myrtifolia*)
               11. Blades linear, oblanceolate, or oblong at least some of them with a few sharp teeth or lobes .... *Q. virginiana* var. *maritima*
         9. Leaves deciduous; blades lobed or sinuate-toothed (or sometimes entire in *Q. Chapmani*).
            14. Blades sinuate-toothed, the rounded teeth more than 15 .... *Q. Michauxii*
            14. Blades lobed, the lobes less than 15.

---

* In this key (as in others) certain variable species are provided for several times; hence the placing of a member of the black oak group under the white oaks, and *vice versa*. This may prevent error when acorns are lacking.

15. Mature twigs pubescent, and leaves with upper pair of lateral lobes squarish, generally larger than the others.
    16. Lower leaf surface tawny-tomentose; bracts of cup flat; acorn not more than half enclosed by the cup ....*Q. stellata*
    16. Lower leaf surface green, or else smoothly and closely white-tomentose; bracts of cup keeled; acorn two-thirds or more enclosed by cup ....*Q. lyrata*
15. Mature twigs glabrous, or if pubescent, then leaves with lateral lobes rounded, fairly equal.
    17. Lobes mostly pointed or squarish; cup nearly covering acorn........ ....*Q. lyrata*
    17. Lobes rounded; cup covering only half of acorn or less.
        18. Twigs brittle at base ....*Q. Durandii* var. *austrina*
        18. Twigs not brittle at base.
            19. Leaves finely tomentose beneath ....*Q. stellata* var. *Margaretta*
            19. Leaves glabrous or glaucous beneath.
                20. Blades mostly over 9 cm. long, their bases acute ....*Q. alba*
                20. Blades mostly under 9 cm. long, or if over, the bases long cuneate.
                    21. Buds obtuse; leaf bases obtuse or acute ....(*Q. Chapmani*)
                    21. Buds acute; leaf bases acute or cuneate ....*Q. nigra*

8. Acorn maturing in the second year, its shell pubescent within; leaves (or some of them) bristle-tipped: *black oaks*.
    22. Leaves entire or merely undulate.
        23. Margins revolute, mostly under 5 cm. long.
            24. Blades linear, oblanceolate, or oblong ....*Q. virginiana* var. *maritima*
            24. Blades short-obovate ....(*Q. myrtifolia*)
        23. Margins flat, mostly over 5 cm. long.
            25. Bark broken into conspicuous squarish blocks (blades ashy-tomentose below)........................*Q. incana*
            25. Bark close or somewhat fissured.
                26. Blades elliptic-oblong, broadest near the middle or sometimes above the middle ....*Q. laurifolia*
                26. Blades linear, linear-lanceolate or linear-oblong, usually slightly broader in the lower portion ....*Q. phellos*
    22. Leaves lobed.
        27. Lower leaf surface light-colored, evenly pubescent.
            28. Blades under 5 cm. wide ....*Q. incana*
            28. Blades over 5 cm. wide.
                29. Lobes ascending, 3-7; base of blade commonly rounded; upper leaves tawny-tomentose beneath ....*Q. falcata*
                29. Lobes spreading, 5-11; base of blade commonly acute; all leaves pale-tomentose beneath ....*Q. falcata* var. *pagodaefolia*
        27. Lower leaf surface green, glabrous, or with pubescence more developed in the vein axils than elsewhere.

30. Blade and petiole averaging under 12 cm. long; blades cuneate in outline, the lobes moslty along the upper half .... *Q. nigra*

30. Blade and petiole averaging over 12 cm. long; blades oval or obovate in outline, the lobes all along the blade.

31. Buds densely woolly throughout, prominently angled .... *Q. velutina*

31. Buds glabrous or slightly pubescent, obscurely angled or terete.

32. Buds sharp-conic, terete, elongate, the larger ones 1 cm. long or more (leaves highly lustrous; sinuses widely open and deep, leaving the body and the usually 5 lobes extremely narrow) .... *Q. laevis*

32. Buds ovoid, obscurely angled, 8 mm. long or less.

33. Blades dull above; lobes tapering outward on most leaves..(*Q. borealis* var. *maxima*)

33. Blades lustrous above; lobes broadening outward on upper leaves.

34. Tufts of hairs conspicuous in vein axils of lower leaf surface; buds glabrous ....*Q. Shumardii*

34. Tufts of hairs lacking or indistinct in vein axils of lower leaf surface; buds pubescent above the middle ....(*Q. coccinea*)

§ Q. ALBA L. White Oak. — Common in moist rich woods; frequent in wet woods and dry sandy woods.

The broad-leaved, shallow-lobed form, which Sargent described as *Q. alba* L. var. *latiloba*, is frequent.

§ Q. DURANDII Buckl. var. AUSTRINA (Small) Palmer. *Q. austrina* Small. Durand Oak. — Collected in "low rich woods across harbor from Charleston," *Harbison* (AA); also "Charleston, S. C." *Harbison* (UNC).

The status of this variety is explained by E. J. Palmer in Amer. Midl. Nat. **33**: 514-519, 1945.

A hybrid which might be sought is × Q. MACNABIANA Sudw. (*Q. Durandii* × *Q. stellata*).

§ Q. FALCATA Michx. *Q. rubra* L. (in part). Southern Red Oak. — Common in pine woods, dry sandy woods, and moist rich woods.

The name *Q. falcata* Michx. var. *triloba* (Michx.) Nutt is applied by some to the extreme form, in dry sandy woods and pine woods, which has but three rather broad lobes confined to the upper half of the blade.

Hybrids which might be sought are:

× Q. BLUFFTONENSIS Trel. (*Q. falcata* × *Q. laevis*).

× Q. JOORII Trel. (*Q. falcata* × *Q. Shumardii*?).

× Q. LUDOVICIANA Sarg. (*Q. falcata* × *Q. phellos*).

× Q. WILLDENOWIANA Zabel (*Q. falcata* × *Q. velutina*).

× Q. SUBINTEGRA Trel. (*Q. falcata* × *Q. incana*).

§ Q. FALCATA Michx. var. PAGODAEFOLIA Ell. *Q. rubra* L. var. *pagodaefolia* (Ell.) Ashe. *Q. Pagoda* Raf. Swamp Red Oak. — Frequent in moist rich woods; occasional elsewhere.

§ Q. INCANA Bartram. *Q. cinerea* Michx. Bluejack Oak. — Frequent in dry sandy woods and pine woods.

See E. D. Merrill, *In defense of William Bartram's binomials*, Bartonia, Nov., 1945, No. 23, 1943-1944, for the latest view of Bartram's names.

Hybrids which might be sought are:

× Q. ASHEANA Little (*Q. incana* × *Q. laevis*).

× Q. ATLANTICA Ashe (*Q. incana* × *Q. laurifolia*).

× Q. CADUCA Trel. (*Q. incana* × *Q. nigra*).

× Q. CRAVENENSIS Little (*Q. incana* × *Q. marilandica*).

× Q. OVIEDOENSIS Sarg. (*Q. incana* × *Q. myrtifolia*).

× Q. PODOPHYLLA Trel. (*Q. incana* × *Q. velutina?*).

§ Q. LAEVIS Walt. *Q. Catesbaei* Michx. Turkey Oak. — Common in dry sandy woods; frequent in pine woods. Hybrids which might be sought are:

× Q. MELLICHAMPII Trel. (*Q. laevis* × *Q. laurifolia*).

× Q. WALTERIANA Ashe (*Q. laevis* × *Q. nigra*).

§ Q. LAURIFOLIA Michx. Laurel Oak. — Common in moist rich woods, wet woods, and dry sandy woods; frequent in shore woods and pine woods.

A form with leaves oblanceolate, rounded at the tip, which has been recognized by some as *Q. laurifolia* Michx. var. *hybrida* Michx., is frequent here.

§ Q. LYRATA Walt. Overcup Oak. — Frequent along low stream banks and occasional in wet woods and cypress swamps.

Hybrids which might be sought are:

× Q. COMPTONAE Sarg. (*Q. lyrata* × *Q. virginiana*).

× Q. STERRETTI Trel. (*Q. lyrata* × *Q. stellata*).

§ Q. MARILANDICA Muench. Blackjack Oak. — Frequent in pine woods and dry sandy woods.

Hybrids which might be sought are:

× Q. BUSHII Sarg. (*Q. marilandica* × *Q. velutina*). Collected at "Charleston, S. C.," *Harbison* (AA).

× Q. INCOMITA Palmer (*Q. marilandica* × *Q. falcata*).

× Q. RUDKINI Britton (*Q. marilandica* × *Q. phellos*).

§ Q. MICHAUXII Nutt. *Q. Prinus* of authors. Swamp Chestnut Oak. — Common in wet woods and moich rich woods.

Svenson has shown in Rhodora **47**:364-366, 1945, that the name *Q. Prinus* L. does not apply to our coastal Swamp Chestnut Oak.

§ Q. NIGRA L. Water Oak. — Common in moist rich woods and pine woods; frequent in wet woods and dry sandy woods; occasional elsewhere.

A form with the three lobes acute, which Sargent designated as *Q. nigra* L. var. *tridentifera*, seems frequent here, and was collected by *Harbison* at Charleston (AA).

Hybrids which might be sought are:

× Q. DEMAREI Ashe (*Q. nigra* × *Q. velutina*).

× Q. GARLANDENSIS Palmer (*Q. nigra* × *Q. falcata*).

× Q. CAPESII W. Wolf (*Q. nigra* × *Q. Phellos*).

§ Q. PHELLOS L. Willow Oak. — Frequent in wet woods; occasional in moist rich woods.

Hybrids which might be sought are:

× Q. FILIALIS Little (*Q. phellos* × *velutina*).

× Q. MOULTONENSIS Ashe (*Q. phellos* × *Q. Shumardii*).

× Q. HETEROPHYLLA Michx. f. (*Q. phellos* × *Q. borealis*).

§ Q. PUMILA Walt. Running Oak. — Common in pine woods and dry sandy woods, associated especially with *Pinus palustris*. It is variable in leaf size and pubescence.

§ Q. SHUMARDII Buckl. Shumard Oak. — Occasional in moist rich woods.

§ Q. STELLATA Wang. Post Oak. — Common in dry sandy woods; frequent in pine woods; occasional in moist rich woods, wet woods, and along stream banks.

§ Q. STELLATA Wang. var. MARGARETTA (Ashe) Sarg. *Q. Margaretta* Ashe. *Q. Margaretta* Ashe var. *stolonifera* Ashe. Dwarf Post Oak. — Common in pine woods and dry sandy woods.

This variety has been found to produce stolons from which a low, shrubby growth develops, identical with Ashe's *Q. Margaretta* var. *stolonifera* (Nos. 3500a and 3500b, *Hunt*). Hence the extensive low stoloniferous growth so frequent in our burned areas is included here.

A hybrid which might be sought is × Q. HARBISONII Sarg. (*Q. stellata* var. *Margaretta* × *Q. virginiana* var. *geminata*).

§ Q. VELUTINA Lam. Black Oak. — Collected in sloping rich woods near creek by Middleton Gardens; also in "sandy soil, Charleston, S. C.," *Harbison* (AA).

§ Q. VIRGINIANA Mill. Live Oak. — Frequent in shore woods, moist rich woods, dry sandy woods, and along stream banks; also abundantly escaped from cultivation.

§ Q. VIRGINIANA Mill. var. GEMINATA (Small) Sarg. *Q. geminata* Small. Twin Live Oak. — Frequent in shore woods.

§ Q. VIRGINIANA Mill. var. MARITIMA (Chapm.) Sarg. — Frequent in pinelands and dry sandy woods.

Although there is no clear demarkation between this variety and the typical form of the species, it is included here because it is so conspicuous in its extreme form on the sand ridges.

Ulmaceae (Elm Family)

CELTIS. Hackberry.

1. Blades long-acuminate, generally lanceolate and mostly over 5 cm. long .... *C. laevigata*
1. Blades abruptly acuminate, generally ovate and mostly under 5 cm. long.
   2. Lower leaf surface nearly glabrous; plant mostly shrubby .... (*C. pumila*)
   2. Lower leaf surface pilose along the veins; plant often a tree .... (*C. pumila* var. *georgiana*)

§ C. LAEVIGATA Willd. *C. mississippiensis* Bosc. Sugarberry, Sugarstone. — Common in wet woods and moist rich woods; frequent in shore woods and old fields; also a common escape from cultivation.

The serrate-leaved form, recognized by some as *C. laevigata* Willd. var. *Smallii* (Beadle) Sarg. (*C. Smallii* Beadle), is not here considered distinct. Serrate-leaved seedlings have been found growing under typical trees of *C. laevigata* (Nos. 3285 and 3286, *Hunt*).

It is to be expected that *C. pumila* Pursh var. *georgiana* (Small) Sarg. will yet be found in our area, since it has been collected on Nelson's Ferry Rd., a few miles beyond our limits, by *Miss Bragg* (M).

PLANERA. Planertree.

§ P. AQUATICA (Walt.) Gmel. Planertree. — Occasional along low stream banks and in cypress swamps.

ULMUS. Elm.

1. Buds glabrous or puberulent; samaras elliptic or oval, deeply notched.
   2. Blades elliptic, mostly under 2.5 cm. wide; buds sharp-pointed; twigs sometimes corky-winged .... *U. alata*
   2. Blades ovate, mostly over 2.5 cm. wide; buds blunt to acute but not sharp-pointed; twigs nevery corky-winged .... *U. americana*
1. Buds densely rusty-brown tomentose; samaras orbicular, not notched (samaras much more broadly winged; leaf-blades much rougher, generally broader, often abruptly long-pointed) .... *U. rubra*

§ U. ALATA Michx. Winged Elm. — Common in wet woods; occasional in moist rich woods.

§ U. AMERICANA L. American Elm. — Common in wet woods; frequent along stream banks and in cypress swamps; occasional in moist rich woods.

A smooth-leaved elm is frequent here, which has been recognized by some as *U. floridana* Chapm., but is treated by Fernald as a form of *U. americana* L.

§ U. RUBRA Muhl. *U. fulva* Michx. Slippery Elm. — Collected by stream at Navy Yard, *Bragg* (M).

Fernald reports in Rhodora **47**:203-204, 1945, that Muhlenberg's prior name applies to this tree.

Moraceae (Mulberry Family)

BROUSSONETIA. Paper-mulberry.

B. PAPYRIFERA (L.) Vent. *Papyrius papyrifera* (L.) Kuntze. Paper-mulberry. — Frequent in old fields and along roads; an escape from cultivation.

FICUS. Fig.

§ F. CARICA L. Fig. — Persisting in old fields and homesteads after cultivation.

MACLURA. Osage-orange.

§ M. POMIFERA (Raf.) Schneid. *Toxylon pomiferum* Raf. Osage-orange, Buzzard-bread. — Collected on Rt. 17, ½ mile west of Mt. Pleasant, *Horlbeck*. An escape from cultivation.

MORUS. Mulberry.

1. Blades scabrous above, tomentose beneath; fruit red or purple ....*M. rubra*
1. Blades smooth above, glabrous or sparingly pubescent beneath; fruit white to pink, or black.
   2. Fruit white to pink (blades glabrous beneath) ....*M. alba*
   2. Fruit black (blades glabrous or sparingly pubescent beneath) ....*M. nigra*

§ M. ALBA L. White Mulberry. — Collected in St. Andrews Parish, *Knowlton* (M); reported by *Bachman*. Introduced in an attempt to develop silk-worm culture.

§ M. NIGRA L. Black Mulberry. — Collected at "Charleston. S. C.," *Willis* (M); Otranto, near Goose Creek Church, *Bragg* (M). An escape from cultivation.

§ M. RUBRA L. Red Mulberry. — Frequent in moist rich woods and wet woods; occasional in shore woods.

Loranthaceae (Mistletoe Family)

PHORADENDRON. American Mistletoe.

§ P. FLAVESCENS (Pursh) Nutt. American Mistletoe. — Frequent on hardwood trees, especially in wet woods.

Polygonaceae (Buckwheat Family)

BRUNNICHIA. Buckwheat-vine.

§ B. CIRRHOSA Banks. Buckwheat-vine. — Collected by stream at Michaux Garden, *Auld, Bragg, Clement, Dawson, Hoch, Hunt, Peacock*.

Batidaceae (Saltwort Family)

BATIS. Saltwort.

§ B. MARITIMA L. Saltwort. — Frequent at salt marsh borders.

Ranunculaceae (Crowfoot Family)

CLEMATIS. Vase-vine.

1. Blades of leaflets coarsely toothed (sometimes also lobed) .... (*C. virginiana*)
1. Blades of leaves or leaflets not coarsely toothed, either entire or lobed.
  2. Plant upright; leaves simple .... (*C. ochroleuca*)
  2. Plant climbing; leaves usually compound.
    3. Flower-stalk without bracts .... *C. crispa*
    3. Flower-stalk with bracts.
      4. Leaflets thick, mostly blunt, the veins prominent and conspicuously reticulate .... *C. reticulata*
      4. Leaflets thin, mostly acute, the veins not prominent nor especially reticulate .... *C. Viorna*

§ C. CRISPA L. *Viorna crispa* (L.) Small. *Viorna obliqua* Small. Blue-jasmine.— Frequent in wet woods and along stream banks and ditches.

Several early spring collections show the linear-leaved condition which has been designated as *C. crispa* L. var. *Walteri* (Pursh) Gray. None of this has appeared among collections made later in the year. This accords with Ralph O. Erickson's conclusion that the variety *Walteri* is merely a spring aspect of *C. crispa*, and with the early observation of W. W. Smith.[44]

§ C. RETICULATA Walt. *Viorna reticulata* (Walt.) Small. — Ralph O. Erickson, in "Taxonomy of *Clematis* section *Viorna*," Ann. Mo. Bot. Gard. **30**:62, 1943, cites a specimen at the Academy of Natural Sciences, Philadelphia, collected by "Rev. J. *Backman*, Charleston, S. Carolina" — evidently *Dr. Bachman*.

§ C. VIORNA L. *Viorna Viorna* (L.) Small. Vase-vine. — Collected at bank of Penny Creek, *Martin* and *Hunt;* and at "Charleston S. Ca.," .... (G).

Menispermaceae (Moonseed Family)

COCCULUS. Coralbead.

§ C. CAROLINUS (L.) DC. *Epibaterium carolinum* (L.) Britton. Carolina Moonseed. — Frequent in old fields; occasional in wet woods and moist rich woods.

MENISPERMUM. Moonseed.

§ M. CANADENSE L. Common Moonseed. — Collected in thicket 2 miles north of Redtop.

Magnoliacae (Magnolia Family)

ILLICIUM. Anise-tree.

§ I. PARVIFLORUM Michx. Star-anise. — Collected at Medway Plantation, where "growing abundantly," *Bragg* (M); reported by *Bachman;* reported by *Mr. S. G. Stoney* as naturalized on the older plantations.

LIRIODENDRON. Yellow-poplar.

§ L. TULIPIFERA L. Yellow-poplar. — Frequent in moist rich woods; occasional in wet woods.

MAGNOLIA. Magnolia.

1. Blades under 25 cm. long.
  2. Leaves green or brown-tomentose beneath .... *M. grandiflora*
  2. Leaves glaucous or white-silky beneath.
    3. Branchlets, petioles, and pedicels glabrous .... *M. virginiana*
    3. Branchlets, petioles, and pedicels silky-pubescent, at least when young .... *M. virginiana* var. *australis*

1. Blades over 25 cm. long.
   4. Leaf bases acute; buds glabrous ....*M. tripetala*
   4. Leaf bases cordate; buds tomentose ....*M. macrophylla*

§ M. GRANDIFLORA L. Magnolia. — Frequent in moist rich woods and along stream banks; occasional in bays, wet woods, and shore woods. Commonly persisting elsewhere after cultivation.

§ M. MACROPHYLLA Michx. Bigleaf Magnolia. — Collected in well-drained rich woods, Ashley River Rd., between Dorchester County Line and Middleton Gardens, *Auld, Dawson, Hunt, Simons, Sottile;* same locality, *Totten* and *Couch* (UNC). This station includes several thriving young trees, which are apparently volunteers from older trees in Middleton Gardens.

Since herbarium specimens of this remarkable flower are scarce and little like the appearance in life, these observations of the collection cited may be of interest: petals light creamy white, the three inner narrowly oval, 15 cm. long, 5.5 cm. wide, with a purple blotch 2 cm. from base, 2 cm. wide; the three outer petals oval, 8 cm. wide at center, 16 cm. long, without a blotch; the three sepals light creamy green, 14 cm. long, 4 cm. wide; axis extending 6 cm. above petals. A kodachrome slide of this flower is in the possession of the writer.

§ M. TRIPETALA L. Umbrella Magnolia. — Moist rich woods southeast of Fenwick Two-mile Heat section of Rockville Rd., Johns Island; moist rich woods on Bee's Ferry Rd., 2 miles southeast of Fort Bull; Ashley River Rd., with *M. macrophylla* described above; Otranto, low woods near Goose Creek Church, *Bragg* (M).

§ M. VIRGINIANA L. Sweetbay. — Common in bays, moist rich woods, wet woods, and wet pine woods; occasional in cypress swamps.

§ M. VIRGINIANA L. var. AUSTRALIS Sarg. — Occurring with the typical form and intergrading with it.

Schisandraceae

SCHISANDRA. Star-vine.

§ S. GLABRA (Brickell) Rehder. *Schizandra coccinea* Michx. Bay Star-vine. — Collected with *Magnolia tripetala* at the Johns Island and Bee's Ferry Rd. stations described above.

Calycanthaceae (Strawberry-Shrub Family)

CALYCANTHUS. Sweet-shrub.

§ C. FLORIDUS L. Strawberry-bush. — Collected at edge of wooded marl bluff, east bank of Ashley River, 1½ miles below Fort Dorchester, probably as an escape from cultivation; at Michaux Garden, *Horlbeck, Hunt, Slocum, Williams;* also at Michaux Garden, *Totten* (UNC).

Lauraceae (Laurel Family)

LINDERA. Spice-bush.

1. Blades tapering at base (petioles relatively long and slender) .. ..*L. Benzoin* var. *pubescens*
1. Blades rounded or cordate at base (petioles shorter) ....(*L. melissaefolium*)

§ L. BENZOIN (L.) Bl. var. PUBESCENS (Palmer & Steyermark) Rehd. *Benzoin aestivale* (L.) Nees var. *pubescens* Palmer & Steyermark. Spike-bush. — Occasional in moist rich woods and wet woods.

LITSEA. Pond-spice.

§ L. AESTIVALIS (L.) Fern. *L. geniculata* (Walt.) Nicholson. *Glabraria geniculata* (Walt.) Britton. Pond-spice. — Collected at edge of pineland pond, Fenwick Two-mile Heat section of Rockville Rd., Johns Island; edge of pineland pond, road to

Chaplin's Landing, south of Rantowles, *Auld, Barrington, Dawson, Horlbeck, Hunt, Peacock, Rogers;* Summerville, *Gibbes* (M); reported from Christ Church Parish, *Mrs. F. H. Horlbeck.*

The nomenclature of this species is explained by Fernald in Rhodora **47**:140-142, 1945.

PERSEA. Persea.

1. Twigs and leaves glabrous ....*P. Borbonia*

1. Twigs tomentose, and leaves pubescent beneath, at least on the midrib ....*P. palustris*

§ P. BORBONIA (L.) Spreng. *Tamala Borbonia* (L.) Raf. Redbay. — Confined to shore woods, but common there.

§ P. PALUSTRIS (Raf.) Sarg. *Tamala pubescens* (Pursh) Small. Swampbay. — Common in moist rich woods and bays; occasional in pine woods, cypress swamps, wet woods, and along stream banks.

The local contrast in appearance of the smooth, mainly scrubby Redbay of our shore woods with the hairy, generally well-developed Swampbay farther inland makes it seem convenient to retain a name for each. However, the difference may be an effect of environmental factors only, and Fernald in Rhodora **47**:149-151 reduces the Swampbay to a form of *Persea Borbonia* (L.) Spreng.

SASSAFRAS. Sassafras.

1. Buds and branchlets glabrous and glaucous; leaf-blades glabrous beneath ....(*S. albidum*)

1. Buds and young branchlets pubescent; leaf blades silky-pubescent beneath at least while young ....*S. albidum* var. *molle*

§ S. ALBIDUM (Nutt.) Nees var. MOLLE (Raf.) Fern. *S. officinale* Nees & Eberm. *S. variifolium* (Salisb.) Ktze. Sassafras. — Common in dry sandy woods, rich moist woods, old fields, and pinelands; occasional in bays.

E. L. Little, Jr., in his *Check List,* reduces *S. albidum* var. *molle* to synonymy with *S. albidum.* A review of the confused nomenclature of *Sassafras* is given by Fernald in Rhodora **38**:178-179, 1936.

Saxifragaceae (Saxifrage Family)

DECUMARIA. Climbing-hydrangia.

§ D. BARBARA L. Climbing-hydrangea. — Common in moist rich woods and wet woods; frequent in cypress swamps and along stream banks.

ITEA. Virginia-willow.

§ I. VIRGINICA L. Virginia-willow. — Common in wet woods; occasional in moist rich woods, cypress swamps, and along stream banks.

Hamamelidaceae (Witch-hazel Family)

FOTHERGILLA. Witch-alder.

1. Shrub without underground stems, isolated ....*F. Gardeni*

1. Shrub with underground stems, gregarious ....*F. parvifolia*

§ ?F. GARDENI Murr. — I am doubtfully placing here two collections so labeled, taken at Summerville by *Fox* (M) and *Taylor* (G). The specimens give no evidence regarding presence or absence of underground stems, which is the only reliable difference I am able to discover between *F. Gardeni* and *F. parvifolia.*

The species name honors Dr. Alexander Garden, 1728-1791, for thirty years a physician in Charleston, whose botanical interests led to extensive correspondence with Linnaeus, Fothergill, Ellis, and other European botanists.

§ F. PARVIFOLIA Kearney. Witch-alder. — Collected in wet pine woods, 2 miles north of Meggett, and in a small shrub-bog (bay), 1½ miles north of Ravenel, *Martin* and *Hunt;* in a roadside ditch 7 miles northeast of Wando, along County Line Rd., *Duncan.*

HAMAMELIS. Witch-hazel.

1. Lower leaf surface smooth .... (*H. virginiana*)
1. Lower leaf surface roughened with minute tubercles .... *H. macrophylla*

§ H. MACROPHYLLA Pursh. Southern Witch-hazel. — Common in moist rich woods; occasional in dry sandy woods, and along stream banks.

All the collections labeled "*H. virginiana*" which I have seen from this area have the minute tubercles on the lower leaf surface which characterize *H. macrophylla.* However, W. C. Coker finds this character so variable elsewhere that he questions the worth of this species.

LIQUIDAMBAR. Sweetgum.

§ L. STYRACIFLUA L. Sweetgum. — Common in old fields, pine woods, moist rich woods, and along stream banks; frequent in dry sandy woods, bays, and wet woods.

Platanaceae (Sycamore Family)

PLATANUS. Sycamore.

§ P. OCCIDENTALIS L. American Sycamore. — Occurring here chiefly as an escape from cultivation, but also occasional in wet woods and along stream banks.

Rosaceae (Rose Family)

AMELANCHIER. Serviceberry.

1. Leaf apex and base dissimilar, the apex acute to short-acuminate, the base rounded to cordate; petals 10-14 mm. long; plant a small tree .... *A. arborea*
1. Leaf apex and base similar, both rounded to low-acute; petals 7-9 mm. long; plant a shrub.
   2. Shrub 1.5 m. tall or less, with underground stems; leaves oval; a plant of dry soil .... *A. obovalis*
   2. Shrub 2 m. tall or more, without underground stems; leaves elliptic; a plant of moist soil .... *A. canadensis*

§ A. ARBOREA (Michx. f.) Fern. *A. canadensis* of authors, including the usage in Small's *Manual* and Coker and Totten's *Trees of the Southeastern States.* Downy Serviceberry. — Occasional in moist rich woods.

See G. N. Jones, American species of *Amelanchier,* Ill. Biol. Monog. **20**: no. 2, 1946, for an explanation of the recent nomenclatorial revisions in *Amelanchier.*

§ A. CANADENSIS (L.) Medic. (Not the *A. canadensis* of authors.) *A. oblongifolia* (T. & G.) Roemer. Shadbush. — Collected in pine woods on Ashley River Rd. near Mateeba Gardens.

§ A. OBOVALIS (Michx.) Ashe. *A. stolonifera* Wiegand, in part. Low Juneberry. — Dry bank, Ashley River Rd., ¼ mile south of Delemar Rd.; ridge in dry sandy woods, east of Rt. 52, 11 miles north of Charleston, *Martin* and *Hunt;* edge of open woods, 8 miles northwest of Summerville, *Duncan.*

ARONIA. Chokeberry.

1. Blades woolly below.
   2. Fruit red .... *A. arbutifolia*
   2. Fruit purple or black .... (*A. prunifolia*)
1. Blades glabrous below (fruit purple or black) .... *A. melanocarpa*

§ A. ARBUTIFOLIA (L.) Ell. Red Chokeberry. — Frequent in bays, low pine woods, seepage slopes, and wet woods.

§ A. MELANOCARPA (Michx.) Ell. Black Chokeberry. — Collected at Summerville, *Robinson* (G); Otranto, *Bragg* (G).

CRATAEGUS. Hawthorn.

The interpretation here is intended to accord with that of *E. J. Palmer*, whose paper, *The Crataegus problem*, Arn. Arb. Jour. **12**:342-362, 1932, demonstrates the perplexing situation in this genus.

1. Leaves tomentose or pubescent beneath.
    2. Blades generally without lobes, the margins crenate-serrate; blades gray-tomentose beneath .... *C. uniflora*
    2. Blades lobed, with 4-8 deep narrow sinuses, the margins of the lobes sharply serrate; blades pilose to glabrous beneath .... *C. Marshallii*
1. Leaves glabrous beneath, except sometimes in the vein axils.
    3. Base of blades truncate or rounded, and the petiole not winged.
        4. Blades mostly 7-11 lobed, the margins of the lobes sharply serrate .... *C. macrosperma*
        4. Blades mostly 3-5 lobed, the margins of the lobes shallowly serrate .... (*C. Phaenopyrum*)
    3. Base of blades cuneate, or at least merging into the petiole, thereby making it noticeably winged.
        5. Veins of the lobed leaves running to the deeper sinuses as well as to the lobes.
            6. Leaves quite regularly 3-lobed .... (*C. Youngii*)
            6. Leaves variable, 3- several-lobed on the stronger shoots, unlobed and oblanceolate to spatulate elsewhere .... *C. spathulata*
        5. Veins of the lobed leaves not running to the sinuses (or else lobed leaves never present).
            7. Blades mostly ovate, irregularly dentate-serrate .... *C. viridis*
            7. Blades oblanceolate to obovate, sharply serrate or crenate-serrate.
                8. Margins sharply serrate; apex frequently acute; blades wholly glabrous .... *C. pyracanthoides*
                8. Margins crenate-serrate; apex rounded; blades with tufts of hairs in the vein axils beneath .... *C. aestivalis*

§ C. AESTIVALIS (Walt.) T. & G. May Hawthorn. — Collected in wet woods, south of Schultz Lake, upper Ashley River.

§ C. MACROSPERMA Ashe. — Collected along dike of Mayrant Backwater in I'On Swamp, and in the wet woods below the dike, *Martin* and *Hunt*.

§ C. MARSHALLII Eggl. *C. apiifolia* Michx. Parsley Hawthorn. — Collected in wet woods, Bear Swamp, east of Rantowles Creek: widely distributed there.

§ C. PYRACANTHOIDES Beadle. — Collected in wet woods, Bear Swamp, east of Rantowles Creek.

A form with pubescent flowering corymbs (instead of glabrous) and with from 15 to 20 stamens (instead of 5 to 12) was described by Sargent as *C. limnophila*, but is considered by Palmer as at most a variety of *C. pyracanthoides*. The collection cited above, which was not in flower, might perhaps be this variety (or form). A "*C. Crus-Galli*" collected by *Ravenel* (M) from the Santee Canal, not far from our area, is a form of *C. pyracanthoides* with 20 stamens; and *Coker* and *Totten* report *C. limnophila* Sarg. from Dorchester and Berkeley Counties.

§ C. SPATHULATA Michx. Littlehip Haythorn. — Collected on a sandy bank of the Edisto River at Leveston Bluff, *Guerard* and *Hunt*.

§ C. UNIFLORA Moench. Dwarf-thorn. — Frequent in dry sandy woods; occasional in old fields and moist rich woods.

§ C. VIRIDIS L. Green Hawthorn. — Frequent in wet woods; occasional along stream banks.

MALUS. Apple.

1. Blades mostly not more than twice as long as broad .... (*M. bracteata*)
1. Blades mostly over twice as long as broad.
   2. Twigs, petioles, and lower leaf surfaces tomentose at maturity .... *M. angustifolia* var. *puberula*
   2. Twigs, petioles, and lower leaf surfaces glabrous at maturity .... (*M. angustifolia*)

§ M. ANGUSTIFOLIA (Ait.) Michx. var. PUBERULA Rehder. — Frequent in moist rich woods; occasional in wet woods.

It may be said that this is a form, rather than a variety, of the Southern Crab Apple, *M. angustifolia*.

PRUNUS. Plum, Peach, Cherry.

1. Leaves persistent (blades glossy, entire or spiny-toothed) .... *P. caroliniana*
1. Leaves deciduous.
   2. Blades smooth or waxy beneath, usually with a dense row of light-colored hairs along each side of lower portion of midrib; flowers and fruits in racemes .... *P. serotina*
   2. Blades not as above; flowers and fruits in umbels or solitary.
      3. Mature first year twigs true green, or red on upper surface; buds woolly, often collateral .... *P. Persica*
      3. Mature first-year twigs dark, or merely tinted with red or green; buds glabrous, not collateral.
         4. Leaf-blades averaging over 6 cm. long; apex generally acuminate; fruits over 18 mm. in diameter .... *P. americana*
         4. Leaf-blades averaging under 6 cm. long; apex generally acute; fruits under 18 mm. in diameter.
            5. Blades lanceolate to narrowly ovate, serrations minute, appressed, averaging 20 per cm.; fruits bright red or yellow, sweet .... *P. angustifolia*
            5. Blades ovate to obovate, serrations more prominent, averaging about 10 per cm.; fruits reddish-purple, sour .... *P. umbellata*

§ P. AMERICANA Marsh. American Plum. — Collected along east bank of Ashley River, above and below Fort Dorchester; also reported by *Bachman*.

§ P. ANGUSTIFOLIA Marsh. Chickasaw Plum. — Common in old fields and dry sandy woods.

§ P. CAROLINIANA (Mill.) Ait. Carolina Cherrylaurel. — Occasional in shore woods, moist rich woods, and along stream banks; frequent along roadsides as an escape from cultivation.

§ P. PERSICA (L.) Batsch. *Amygdalus Persica* L. Peach. — A common escape from cultivation. This is a favorite ornamental tree with the country Negroes.

§ P. SEROTINA Ehrh. *Padus virginiana* (L.) Mill. *Padus serotina* (Ehrh.) Agardh. Black Cherry, Bird Cherry. — Common in old fields, along roadsides, in dry sandy woods and pine woods; frequent in moist rich woods.

§ P. UMBELLATA Ell. Flatwoods Plum, Hog Plum. — Occasional in dry sandy woods.

PYRUS. Pear.

P. COMMUNIS L. Pear. — Occasional in old fields as an escape from cultivation.

ROSA. Rose.

1. Stipules almost free from the petiole or fallen off.
  2. Leaflets mostly 3; branches glabrous .... *R. laevigata*
  2. Leaflets 5-9; branches pubescent .... (*R. bracteata*)
1. Stipules adnate to the petioles.
  3. Leaflets 3, or 5 on vigorous shoots .... *R. setigera*
  3. Leaflets 5 or more.
    4. Rachis with glandular hairs.
      5. Lower stem prickles straight, terete .... (*R. carolina* var. *glandulosa*)
      5. Lower stem prickles curved, flattened.
        6. Leaflets broadly oval; apex rounded to acute .... (*R. Eglanteria*)
        6. Leaflets ovate; apex acute to short-acuminate .... (*R. micrantha*)
    4. Rachis without glandular hairs.
      7. Stipules pectinate .... (*R. multiflora*)
      7. Stipules only minutely roughened on edges.
        8. Prickles straight .... (*R. carolina*)
        8. Prickles curved.
          9. Leaflets mostly 7; flowers usually corymbose; fruits about 12 mm. thick .... *R. palustris*
          9. Leaflets mostly 5; flowers usually solitary or paired; fruits 8-9 mm. thick .... (*R. floridana*)

§ R. LAEVIGATA Michx. Cherokee Rose. — Collected in old fields and roadside thickets, probably as an escape from cultivation; frequent.

§ R. PALUSTRIS Marsh. Swamp Rose. — Frequent in wet woods, roadside ditches, and fields bordering fresh water marshes.

§ R. SETIGERA Michx. Prairie Rose. — Occasional in roadside ditches.

RUBUS. Blackberry.

The blackberries seem to have been the most neglected, botanically, of all our plants. Collectors have been discouraged not so much by their vicious prickles as by their equally painful confusion of kinds. For the most part they were dismissed as variable or hybrid forms of the few species described long ago. However, following a long life-time of study, L. H. Bailey (*Rubus in North America*, Gentes Herbarum 5:1-932, 1945) lists 376 species of true blackberries and dewberries (subgenus *Eubatus*) and predicts that many more will yet be distinguished. Opinions differ widely on this point. In any case, it is evident that much more collecting and study must be done before the blackberries of any one region can be confidently named.

Of the six subgenera of *Rubus*, there is represented in this area only the largest one, *Eubatus*. Of the ten sections of the *Eubati*, we have possibly five. It is hoped that the key here offered will lead the student to the proper section. The species names that follow are to be regarded as for tentative identification only. Included are the eight species and varieties actually collected here, plus the ten others so far credited to the Coastal Plain south of Virginia and north of Florida. To include more would have multiplied the length of the key, though still without achieving accuracy. If interested in obtaining an accurate identification, as well as rendering a service to botanical science, the student might send *complete specimens* to the Bailey Hortorium, Ithaca, N. Y. By this is meant both primocane and floricane from the same root, preferably with flowers and later with fruit. A statement regarding the habit of the plant, whether erect or trailing and rooting at the tip, would also be valuable.

1. Plants mostly trailing, eventually rooting at the tips (only the young primocanes sometimes erect).
  2. True prickles absent; stiff bristles sometimes present, but these neither thickened at the base nor curved.
    3. Stems with hispid hairs or stiff bristles; stems distinctly woody .... Sect. 3. HISPIDI : (*R. vigil*)
    3. Stems glabrous; stems nearly herbaceous .... *R. Enslenii*, of Sect. 6
  2. True prickles present, these thickened at base and often curved, and noticeably stouter than hairs, or bristles, which may also be present.
    4. Primocanes with bristles as well as prickles; leaves persistent, i. e., last year's leaves present on the floricane.................... Sect. 5. VEROTRIVIALES : *R. trivialis*
    4. Primocanes without bristles; leaves persistent or deciduous.
      5. Leaves persistent, or if deciduous, then leaflets narrowly ovate to lanceolate (at least twice as long as broad) ....Sect. 5. VEROTRIVIALES : (*R. ictus*)
      5. Leaves deciduous, or if persistent, then leaflets ovate to broadly ovate (less than twice as long as broad).
        6. Foliage gray or white-tomentose beneath ....Proceed to 13, CUNEIFOLII.
        6. Foliage green beneath ....Sect. 6. FLAGELLARES :
          7. Primocane leaves with 5 leaflets.
            8. Floricane leaflets all acute-tipped ....(*R. ashei*)
            8. Floricane leaflets, or at least the center one, blunt-tipped ....(*R. serenus*)
          7. Primocane leaves with 3 leaflets.
            9. Floricanes prostrate, the axis trailing on the ground.
              10. Primocane leaflets all acute-tipped ....(*R. cordialis*)
              10. Primocane leaflets, or some of them, acuminate ....(*R. serenus*)
            9. Floricanes arching, the axis ultimately contacting the ground only at its recurved tip.
              11. Primocane leaflets pubescent; floricane leaflets ovate ....*R. Enslenii*
              11. Primocane leaflets glabrous; floricane leaflets mostly obovate...... .... (*R. bonus*)

1. Plants erect, or sometimes overburdened, but not normally rooting at the tips.
  12. Prickles few and weak; plants nearly herbaceous ....*R. Enslenii*, of Sect. 6
  12. Prickles abundant and sharp; plants woody.
    13. Foliage white-tomentose or cinereous; leaflets mostly cuneate; plants stiffly erect ....Sect. 7. CUNEIFOLII :
      14. Terminal leaflets of primocane leaves entire on the lower third, and cuneate.
        15. Floricane leaflets rounded at apex, short-obovate ....*R. cuneifolius* var. *subellipticus*
        15. Floricane leaflets not rounded at apex.
          16. Primocane leaflets truncate to rounded at apex except for a small abrupt cusp ....*R. cuneifolius*
          16. Primocane leaflets acute or abruptly acuminate at apex ....*R. cuneifolius* var. *austrifer*
      14. Terminal leaflets or primocane leaves mostly serrate on the lower third, and somewhat rounded at base.
        17. Prickles of primocanes slender; floricane leaflets mostly acute at apex ....*R. georgiensis*
        17. Prickles of primocanes strong, broadly flaring at base; floricane leaflets mostly blunt at apex ....(*R. Randolphiorum*)

13. Foliage somewhat pubescent but not white-tomentose or cinereous; leaflets at least of primocanes lanceolate to ovate; plants flexuous, mostly tall ....Sect. 10. ARGUTI :

18. The upper three leaflets of the mature primocane leaves ovate-lanceolate, the length usually more than twice the width.

19. Primocane leaflets sharply and irregularly cut-serrate (many of the indentations 3-4 mm. deep); primocanes obscurely angled; plants rather weak, diffuse ....*R. argutus*

19. Primocane leaflets shallowly and closely serrate; primocanes strongly angled; plants more firmly erect ....*R. louisianus*

18. The upper three leaflets of the mature primocane leaves ovate, the length not more than twice the width.

20. Primocane leaves with leaflets varying between 3 and 5, commonly 3, these rather small, averaging 6 cm. long and not over 3 cm. wide .... (*R. abundiflorus*)

20. Primocane leaves regularly with 5 leaflets, these larger, at least the central one over 8 cm. and 4 cm. wide ....(*R. par*)

§ R. ARGUTUS Link. Highbush Blackberry. — Apparently common in old fields, roadsides, thickets, and clearings.

§ R. CUNEIFOLIUS Pursh. Sand Blackberry. — Frequent in dry sandy woods, sandy pine woods, old fields, and roadsides.

§ R. CUNEIFOLIUS Pursh var. AUSTRIFER Bailey. — Frequent in the same localities as the species.

§ R. CUNEIFOLIUS Pursh var. SUBELLIPTICUS Fernald. — Frequent in the same localities as the species.

§ ?R. ENSLENII Tratt. — Incomplete specimens collected in wet woods south of Schultz Lake, upper Ashley River, and in dry but fairly rich woods, Willow Hall Rd., 1.2 miles east of Rt. 511, both appear to key out here, but without flowering and fruiting material the presence of this species remains in question.

§ R. GEORGIENSIS Bailey. — A specimen collected at edge of pine woods above the railroad cut north of Ordnance Depot Rd. is probably this.

§ R. LOUISIANUS Berger. — Apparently frequent in open wet woods and roadside ditches.

§ R. TRIVIALIS Michx. Southern Dewberry. — Common in old fields and roadsides, moist rich woods, wet woods, and shore woods.

Leguminosae (Legume Family)

ALBIZZIA.

§ A. JULIBRISSIN Durazz. Silktree, Mimosa. — Frequently escaped from cultivation along roadsides and at old fields and homesteads. A clump still grows in the Michaux Garden, where it was first introduced by André Michaux.

AMORPHA. Lead-plant.

1. Stems glabrous ....(*A. Curtissii*)

1. Stems pubescent.

2. Flowers bluish-white; lowest pair of leaflets on the rachis within their width of the stem ....*A. herbacea*

2. Flowers purple; lowest pair of leaflets on the rachis more than their width away from the stem.

3. Pubescence of the young leaves and twigs gray ....(*A. fruticosa*)

3. Pubescence of the young leaves and twigs yellow or orange ....*A. fruticosa* var. *croceolanata*

§ A. FRUTICOSA L. var. CROCEOLANATA (Wats.) Schneid. *A. croceolanata* Wats. Indigo-bush. — Common along stream banks, and sometimes along roadside ditches; frequent in wet woods.

§ A. HERBACEA Walt. — Edge of dry sandy thicket, Rt. 511 at Willow Hall Rd.; roadside ditch, Rt. 402, near Wadboo Creek; north of Cooper River, *Horlbeck*.

CERCIS. Redbud.

§ C. CANADENSIS L. Eastern Redbud. — Frequent in moist rich woods.

GLEDITSIA. Honeylocust.

1. Leaflets pubescent on petiolule and at least the basal portion of the midrib beneath; fruits long, many-seeded .... *G. triacanthos*
1. Leaflets glabrous throughout; fruits short, one-seeded .... *G. aquatica*

§ G. AQUATICA Marsh. Waterlocust. — Collected on low river bank, Slann's Bridge, upper Ashley River; in cypress swamp, west of Schultz Lake, upper Ashey River; and low river bank, Edisto River, northwest of Leveston Bluff. These specimens were determined by the glabrous petiolules and midribs, as no fruits were found. *Elliott* collected this species from "Santee" (M), which, however, is outside our area, as is *Coker's* collection from the Santee swamp on Rt. 17 (UNC).

§ G. TRIACANTHOS L. Honeylocust. — Frequent in old fields and along roadsides; occasional in moist rich woods; in all cases, however, it is near habitations or old homesteads and appears to be an escape from cultivation.

ROBINIA. Locust.

1. Flowers white; fruits glabrous; trees .... *R. Pseudoacacia*
1. Flowers pink; fruits hispid; shrubs.
   2. Branches bristly-hispid .... *R. hispida*
   2. Branches not bristly-hispid.
      3. Plant villous; peduncles not glandular-hispid (branchlets with short spines) .... (*R. Elliottii*)
      3. Plant puberulent to glabrate; peduncles glandular-hispid (branchlets unarmed or with short spines).
         4. Shrub over 1 m. tall .... (*R. Boyntonii*)
         4. Shrub under 1 m. tall .... (*R. nana*

§ R. HISPIDA L. Rose-acacia. — Spreading after cultivation on an old homestead on Rt. 64, about 2½ miles northeast of Summerville.

§ R. PSEUDOACACIA L. Black Locust. — Frequent as an escape from cultivation in old fields and along roadsides.

(The lovely pink locusts, *R. Boyntonii* Ashe, *R. Elliottii* (Chapm.) Ashe, and *R. nana* Ell., so noticeable near Myrtle Beach, have not yet been collected south of the Santee.)

SCHRANKIA. Sensitive-briar.

§ S. ANGUSTATA T. & G. *Leptoglottis microphylla* (Dryand.) Britton. *Morongia angustata* Britton. Sensitive briar, Touch-me-not. — Frequent in dry sandy woods and pine woods.

WISTERIA. Wisteria.

1. Leaflets narrowly ovate, gradually tapering to a blunted tip; racemes compact; fruits glabrous .... *W. frutescens*
1. Leaflets ovate, abruptly acuminate; racemes lax; fruits velvety.
   2. Leaflets 7-13 .... *W. sinensis*
   2. Leaflets 13-19 .... (*W. floribunda*)

§ W. FRUTESCENS (L.) Poir. *Kraunhia frutescens* (L.) Britton. American Wisteria. — Common along stream banks; occasional in wet woods and bays.

§ W. SINENSIS (Sims) Sweet. Chinese Wisteria. — A frequent escape from cultivation in old fields and homesteads.

Rutaceae (Rue Famly)

ZANTHOXYLUM. Prickly-ash.

§ Z. CLAVA-HERCULIS L. Hercules-club. — Frequent on beach dunes; occasional in shore woods.

Simaroubaceae (Ailanthus Family)

AILANTHUS. Ailanthus.

§ A. ALTISSIMA (Mill.) Swingle. Ailanthus, Tree-of-Heaven. — An escape in city lots.

Meliaceae (Mahogany Family)

MELIA. Chinaberry.

§ M. AZEDERACH L. Chinaberry, Pride-of-India. — Common along roadsides and in old fields and homesteads as an escape from cultivation.

The popular compactly-branched variety, *M. Azederach* L. var. *umbraculifera* Sarg., or Umbrella-tree, has not to my knowledge been found escaped.

Euphorbiaceae (Spurge Family)

CROTON.

§ C. PUNCTATUS Jacq. Beach-tea. — Common on beach dunes; occasional at salt marsh borders.

SAPIUM.

§ S. SEBIFERUM (L.) Roxb. *Triadica sebifera* (L.) Small. Tallowtree. — Frequent at salt marsh borders; occasional in old fields and wet woods. The presence of this Chinese tree here was noted as early as 1784 by *Schoepf*. It thrives where close to the moderating effect of salt water.

SEBASTIANA.

§ C. FRUTICOSA (Bartr.) Fern. *S. ligustrina* (Michx.) Muell. Arg. Sebastian-bush.— Collected on stream bank, Daisy Swamp, ¾ mile north of Rt. 2; on sandy bluff, Edisto River at Leveston Bluff, *Guerard* and *Hunt*.

Anacardiaceae (Cashew Family)

*RHUS. Sumac.

1. Leaflets 3.
   - *2. Stems erect: a shrub; leaflets thick, coarsely crenate-lobed; frequent on sand ridges and in dry pine woods .... *R. Toxicodendron**
   - *2. Stems not erect: a plant either climbing by aerial rootlets, or forming a stoloniferous system with short upright branches; leaflets not thick, entire to coarsely toothed; abundant in moist woods and swamps .... *R. radicans**
1. Leaflets more than 3.
   - 3. Rachis winged; twigs pubescent.
     - 4. Leaflets acute or acuminate .... *R. copallina*
     - 4. Leaflets, or some of them, blunt (leaflets smaller and more numerous) .... *R. copallina* var. *leucantha*
   - 3. Rachis terete; twigs glabrous.
     - 5. Leaflets serrate; fruit red .... (*R. glabra*)
     - *5. Leaflets entire; fruit white .... *R. vernix**

---

* *R. Toxicodendron*, *R. radicans*, and *R. vernix* are poisonous to touch.

§ R. COPALLINA L. Winged Sumac. — Common in old fields, dry sandy woods, and pine woods; frequent in short woods, salt marsh borders, and moist rich woods; occasional elsewhere.

§ R. COPALLINA L. var. LEUCANTHA (Jacq.) DC. — Occasional in dry sandy fields.

§ *R. RADICANS L. *R. Toxicodendron* of authors, not L. *Toxicodendron radicans* (L.) Kuntze. Poison-ivy. — Common in moist rich woods, wet woods, and along stream banks; frequent in old fields, shore woods, and cypress swamps.

§ *R. TOXICODENDRON L. *Toxicodendron Toxicodendron* (L.) Britton. Poison-oak. — Frequent in dry sandy woods and dry pine woods.

§ *R. VERNIX L. *Toxicodendron vernix* (L.) Kuntze. Poison Sumac. — Confined in our area to seepage slopes; frequent there.

Cyrillaceae (Cyrilla Family)

CYRILLA. Cyrilla.

§ C. RACEMIFLORA L. Swamp Cyrilla. — Frequent in bays and along stream banks; occasional in wet woods.

Aquifoliaceae (Holly Family)

ILEX. Holly.

1. Leaves leathery, persistent (berries** red or black).
  2. Margins with sharp spines, or occasionally entire except for one terminal spine (berries red).
    3. Blades oval, over half as wide as long .... *I. opaca*
    3. Blades elliptic or oblanceolate, less than half as wide as long .... *I. Cassine*
  2. Margins without sharp spines, though sometimes with weak spinescent teeth.
    4. Blades linear to very narrowly elliptic (berries red).
      5. Twigs flexuous, branching variously .... *I. Cassine*
      5. Twigs very rigid, nearly at right angles to the branch and closley spaced .... *I. myrtifolia*
    4. Blades oblanceolate to oval.
      6. Margins crenate nearly to the base; blades mostly blunt or rounded at both ends (berries red) .... *I. vomitoria*
      6. Margins and blades not as above.
        7. Leaf-blades averaging 3 cm. long or less, narrow-oblong to linear (berries red) .... *I. myrtifolia*
        7. Leaf-blades averaging over 3 cm. long, narrowly elliptic or oblanceolate to oval.
          8. Blades mostly acute at base, prevailingly oval to obovate (margins often prickly with weak spinescent teeth; berries black, or purplish before ripening) .... *I. coriacea*
          8. Blades mostly cuneate at base, prevailingly elliptic to oblanceolate.
            9. Margins remotely appressed-serrate, but not prickly, above the middle; leaves scarcely leathery; berries black .... *I. glabra*
            9. Margins entire to slightly prickly; leaves decidedly leathery; berries red.

---

* *R. Toxicodendron*, *R. radicans*, and *R. vernix* are poisonous to touch.

** The berries (actually drupes) may occasionally be yellow in any of the normally red-berried species.

10. Blades less than four times as long as wide: oblanceolate, elliptic, or obovate .... *I. Cassine*

10. Blades mostly four times or more as long as wide: narrowly oblong-elliptic to oblanceolate .... (*I. Cassine* var. *angustifolia*)

1. Leaves membranous, deciduous (berries red).

11. Apex blunt or retuse, though often much narrowed just below the tip.

12. Blades spatulate, over 3 cm. long .... *I. decidua*

12. Blades elliptic, under 3 cm. long .... *I. decidua* var. *Curtissii*

11. Apex acute or short-acuminate.

13. Margins mostly flat to convex just below the tip, hence the apex acute .... (*I. Amelanchier*)

13. Margins mostly concave just below the tip, hence the apex short-acuminate.

14. Nutlets smooth (veins often raised on lower leaf surface and impressed on upper surface) .... (*I. verticellata*)

14. Nutlets ribbed (veins scarcely raised on lower leaf surface, not impressed on upper surface) .... *I. ambigua*

§ I. AMBIGUA (Michx.) Torr. *I. caroliniana* (Walt.) Trelease. Carolina Holly.— Collected in moist rich woods, ½ mile northeast of intersection of Humbert Rd. and Chisholm Rd., Johns Island; dry sandy woods, Williams tract, Martin's Point Rd., Wadmalaw Island, *Mrs E. A. Williams;* "James Island," Harbison (AA, UNC).

An *Ilex* in the Elliott Herbarium (M), collected by *Macbride* in "St. John's" [Parish] deserves comment here, although it probably was taken from outside our area. Elliott labeled it "*Prinus ambigua*," and it was re-labeled "*Ilex caroliniana*" by Beadle and Boynton. It does not, however, check with *Ilex ambigua* as understood here, because the lower leaf surface, and to a lesser extent the upper, is finely and evenly tomentose.

The complete nomenclatorial histories of *I. ambigua* and *I. Amelanchier* are discussed by Fernald in Rhodora **41**:425-429, 1939, and by E. L. Little, Jr., in Wash. Acad. Sci. Jour. **33**:131. 1943.

§ I. CASSINE L. Dahoon. — Occasional at salt marsh borders, in shore woods, wet woods, cypress swmaps, and on seepage slopes.

A hybrid which might be sought is × I. ATTENUATA Ashe (*I. Cassine* × *I. opaca*).

§ I. CORIACEA (Pursh) Chapm. *I. lucida* (Ait.) T. & G. Large Gallberry. — Frequent in bays; occasional on seepage slopes and in wet woods.

§ I. DECIDUA Walt. Possumhaw. — Frequent in wet woods and along stream banks.

§ I. DECIDUA Walt. var. CURTISSII Fern. *I. Curtissii* (Fern.) Small. — Collected on low bank of Edisto River, northwest of Leveston Bluff.

§ I. GLABRA (L.) Gray. Gallberry. — Common in pine woods, dry sandy woods, and bays; occasional in moist rich woods and wet woods.

§ I. MYRTIFOLIA Walt. *I. Cassine* L. var. *myrtifolia* (Walt.) Sarg. Myrtle Dahoon. — Collected at Black Tom Bay, Rt. 2, 3 miles northwest of Carn's Crossroads.

The abundant and quite uniform collections of this from the Southeastern Coastal Plain at the University of North Carolina Herbarium seem to justify retaining this as a species.

§ I. OPACA Ait. American Holly. — Common in moist rich woods, wet woods, and along stream banks; occasional in dry sandy woods. The entire-leaved form (*I. opaca* Ait. forma *subintegra* Weatherby) is occasionally seen.

§ I. VOMITORIA Ait. Yaupon, Christmas-berry. — Common at salt marsh edges and in shore woods; frequent in moist rich woods; occasional in dry sandy woods.

Celastraceae (Staff-Tree Family)

EUONYMUS. Euonymus.

1. Petioles under 5 mm. long; twigs square; fruits red .... *E. americana*
1. Petioles over 1 cm. long; twigs nearly terete; fruits purple .... (*E. atropurpureus*)

§ E. AMERICANA L. Strawberry-bush. — Frequent in moist rich woods and wet woods.

Aceraceae (Maple Family)

ACER. Maple.

1. Leaves compound .... *A. Negundo*
1. Leaves simple.
   2. Lobes entire or with only 2-4 blunt teeth; flowers filiform-pedicelled, in drooping clusters appearing with the leaves; samaras green .... *A. barbatum*
   2. Lobes with numerous teeth; flowers sessile or short-pedicelled, in dense clusters appearing before the leaves; samaras red, or if green, pink-tinted.
      3. Bases of blades subcordate; lobes prominently toothed.
         4. Mature leaves glaucous, or tomentose below on veins only .... *A. rubrum*
         4. Mature leaves woolly-tomentose below .... *A. rubrum* var. *tomentosum*
      3. Bases of blades rounded; lobes shallowly toothed .... *A. rubrum* var. *trilobum*

§ A. BARBATUM Michx. *A. floridanum* (Chapm.) Pax. *Saccharodendron floridanum* (Chapm.) Nieuwl. Florida Maple. — Collected at Michaux Garden, *Bragg* (M), and *Coker* (UNC); at Hinson Plantation, James Island, "Transplanted from Michaux Garden," *Bragg* (M), and *Coker* (UNC). Mellichamp's collection from "near Charleston" (NY) was perhaps from the Michaux Garden also. See Coker, Bull. Torr. Bot. Club **36**:635, 1909.

Two trees still grow between the Army dog kennels on the Michaux Garden site, producing samaras liberally.

That Michaux's name truly applies to this species is shown by Fernald in Rhodora **47**:156-160, 1945.

§ A. NEGUNDO L. *Negundo Negundo* (L.) Karst. Boxelder. — Occasional in wet woods and moist rich woods.

§ A. RUBRUM L. *Rufacer rubrum* (L.) Small. Red Maple. — Common and abundant in wet woods; common in cypress swamps, frequent in moist rich woods and along streams.

§ A. RUBRUM L. var. TOMENTOSUM Desf. — Collected in wet woods north of Parker's Ferry Rd., ¾ mile west of Moberry Rd.; also on bank of Edisto River northwest of Leveston Bluff.

§ A. RUBRUM L. var. TRILOBUM K. Koch. *A. rubrum* L. var. *tridens* Wood. *Rufacer carolinianum* (Walt.) Small. Carolina Red Maple. — Collected on floating mats of vegetation on the Goose Creek Reservoir.

Sapindaceae (Soapberry Family)

AESCULUS. Buckeye.

§ A. PAVIA L. Red Buckeye. — Frequent in moist rich woods and wet woods.

This is here treated as a single variable species. The only constant distinction seems to be between plants with glabrous leaves and plants with leaves finely tomentose below. The two are about equally frequent, and can be found together in the same groups. In both cases the flowers are mostly red, but are also tinted with varying degrees of yellow when fully developed. (When dried, the colors change irregularly, sometimes the red, at other times the yellow, disappearing.) However, other entities concerning our area have been proposed which are distinguished as follows:

1. Leaves glabrous or only slightly pubescent on the midrib beneath .... *A. Pavia* L.

1. Leaves finely and evenly tomentose beneath.
  2. Flowers red and yellow .... *A. discolor* Pursh
  2. Flowers bright red .... *A. discolor* Pursh var. *mollis* (Raf.) Sarg.

By this key our buckeyes would fall about equally into *A. Pavia* and *A. discolor*, with *A. discolor* var. *mollis* apparently absent. Collections at the Arnold Arboretum, however, include specimens labeled *A. Pavia* taken from our area by *Sargent*, *Harbison* and *Rehder*, and one labeled *A. discolor* var. *mollis* by *Harbison;* except for the variety, *A. discolor* is not recorded there from South Carolina. Perhaps the contradictions in *Aesculus* (and in some of our other genera) will eventually be resolved by methods such as Camp has applied to *Vaccinium*.

SAPINDUS. Soapberry.

§ S. SAPONARIA L. Wingleaf Soapberry. — Collected at Snee Farm, Long Point Rd, near Rt. 17. 5.5 miles northeast of Mt. Pleasant, *Horlbeck;* also reported by *Bachman*. An escape from cultivation.

Rhamnaceae (Buckthorn Family)

BERCHEMIA

§ B. SCANDENS (Hill) K. Koch. Supple-jack. — Frequent in wet woods; occasional in shore woods, moist rich woods, cypress swamps, and along stream banks.

CEANOTHUS. Red-root.

1. Blades 4-10 cm. long; panicles large, corymbose .... *C. americanus*
1. Blades less than 4 cm. long; panicles narrow, scattered .... *C. americanus* var. *intermedius*

§ C. AMERICANUS L. New Jersey-tea. — Collected at Otranto, near Goose Creek Church, *Bragg* (M).

§ C. AMERICANUS L. var. INTERMEDIUS (Pursh) K. Koch. — Common in pine woods and dry sandy woods.

RHAMNUS. Buckthorn.

§ R. CAROLINIANA Walt. Carolina Buckthorn. — Collected by *Ravenel*, "near Charleston" (Cv); reported by *Bachman*.

SAGERETIA

§ S. MINUTIFLORA (Michx.) Trelease. Buckthorn. — Collected at Kiawah Island, *Totten* (UNC); reported by *Bachman*.

ZIZIPHUS.

§ Z. JUJUBA Mill. *Ziziphus Ziziphus* (L.) Karst. Common Jujube. — Collected at Mt. Pleasant, *J. E. Royall;* abundantly escaped from cultivation there.

Vitaceae (Grape Family)

AMPELOPSIS.

1. Leaves simple .... (*A. cordata*)
1. Leaves bipinnately compound .... *A. arborea*

§ A. ARBOREA (L.) Koehne. *Cissus arborea* (L.) Des Moulins. Peppervine. — Common in old fields and along roadsides and stream banks; frequent in shore woods, moist rich woods, wet woods, and cypress swamps.

PARTHENOCISSUS. Virginia-creeper.

§ P. QUINQUEFOLIA (L.) Planch. Virginia-creeper. — Common in moist rich woods

and wet woods; frequent along streams and in shore woods; occasional in old fields, pine woods, and dry sandy woods.

A hirsute form of this is occasionally seen, which Rehder records as *P. quinquefolia* (L.) Planch. var. *hirsuta* (Pursh) Planch.

VITIS. Grape.

1. Bark white-speckled, not shreddy .... *V. rotundifolia*
1. Bark not white-speckled, shredding with age.
   2. Leaf-blades glabrous beneath or merely puberulent on the veins .... *V. vulpina*
   2. Leaf-blades tomentose or floccose beneath.
      3. Blades densely and evenly tomentose beneath when mature .... *V. Labrusca*
      3. Blades floccose or cobwebby along the veins when mature.
         4. Stems terete; twigs glabrous in age, though often tomentose when young...... .... *V. aestivalis*
         4. Stems angled; twigs tomentose throughout season.
            5. Blades with the terminal point long-extended, usually flanked on each side by a lobe or large tooth; serrations small and close.
               6. Pubescence of lower leaf surface gray .... (*V. cinerea*)
               6. Pubescence of lower leaf surface rusty ....(*V. cinerea* var. *floridana*)
            5. Blades with terminal point not extended, if flanked the lobes obscure and not pointed; serrations large (pubescence of lower leaf surface rusty) .... *V. rufotomentosa*

§ V. AESTIVALIS Michx. Summer Grape. — Common in old fields, along roadsides and the edges of woods, and in moist rich woods; frequent in wet woods; occasional in pine woods, dry sandy woods, and along stream banks.

§ V. ROTUNDIFOLIA Michx. *Muscadinia rotundifolia* (Michx.) Small. Scuppernong. — Common in old fields, along roadsides and the edges of woods, in pine woods, shore woods, and moist rich woods; frequent in wet woods and dry woods; occasional in bays.

§ V. LABRUSCA L. Fox Grape. — Collected at Michaux Garden, *Auld, Bragg, Clement, Dawson, Hoch, Hunt, Peacock*; at Summerville, *Hunnewell* (G); reported by *Bachman*.

§ V. VULPINA L. *V. cordifolia* Lam. Frost Grape. — Occasional in roadside thickets, old fields, moist rich woods, wet woods, and along streams.

The much-disputed nomenclature of this species is discussed by Fernald in Rhodora **41**:431-434, 1939.

§ V. RUFOTOMENTOSA Small. Redshank Grape. — Occasional along stream banks and in wet woods.

Fernald reports that this is what Le Conte described in 1853 as *V. araneosa* (Rhodora **41**:434-435,1939). In this case Le Conte's name would become the correct one.

(Mention should also be made of *V. cinerea* Engelm. var. *floridana* Munson [*V. Simpsonii* Munson], the Currant Grape. Although I have been unable to discover any occurrence of this within our limits, it has been taken by *Ravenel* from the Santee Canal (G), and by *Godfrey* and *Tryon* from 2 miles west of Rt. 17, near the south bank of the Santee (G)).

Tiliaceae (Linden Family)

TILIA. Basswood.

The basswoods of our area all seem to belong to *Tilia caroliniana* Mill., or its variety *T. caroliniana* Mill. var. *rhoophila* Sarg. Even the status of the latter seems doubtful, since the shoots from stumps of *T. caroliniana* assume the hairy characters of its variety, retaining these well past the age of fruiting. Harbison's collection of "*Tilia*

georgiana Sarg." from Charleston (AA) seems to match these more vigorous shoots of *T. caroliniana*, as does also Mellichamp's collection from "Beaufort District" (AA), which has been referred to *T. georgiana* Mill. var. *crinita* Sarg.

It is conceivable that *Tilia heterophylla* Vent. or even *Tilia floridana* Small may exist here, but these are not included in the key. These several species of *Tilia* closely intergrade, and their characters vary with the circumstances of growth. To include these would increase rather than lessen the chance that the student will misidentify his specimen. In any case, identification in this perplexing genus should be regarded as tentative until verified through one of the larger herbaria. Material sent away for determination should be complete, including spring and summer growth, sun and shade leaves, and flowering material.

1. Blades thin, pale pubescent beneath, mostly cordate; twigs glabrous when fully grown .... *T. caroliniana*
1. Blades thick, larger, light brown tomentose beneath, obliquely truncate to shallowly cordate; twigs tomentose even when fully grown........ *T. caroliniana* var. *rhoophila*

§ T. CAROLINIANA Mill. Carolina Basswood. — Frequent in moist rich woods; occasional in wet woods.

§ T. CAROLINIANA Mill. var. RHOOPHILA Sarg. — Occasional in moist rich woods.

Sterculiaceae (Sterculia Family)

FIRMIANA.

§ F. PLATANIFOLIA (L. f.) Schott & Endl. *F. simplex* (L.) Wight *Sterculia platanifolia* L.f. Chinese Parasoltree; Japanese Varnish-tree. — Occasionally escaped from cultivation. This was introduced to Charleston by André Michaux.

Theaceae (Tea Family)

CAMELLIA.

§ C. SINENSIS (L.) Ktze. *Thea sinensis* L. Tea. — Collected as an escape northwest of Wallace River at Holly Grove, formerly the Tyler Tea Plantation, where it forms the understory in a young stand of *Pinus Taeda*.

GORDONIA.

§ G. LASIANTHUS (L.) Ellis. Loblolly-bay. — Frequent in bays; occasional in pine woods, rich moist woods, and wet woods.

STEWARTIA.

§ S. MALACHODENDRON L. *Stuartia Malachodendron* L. Silky-camellia. — Collected at top of ravine by small stream southeast of Middleton Gardens; in moist rich woods southeast of Fenwick Two-mile Heat section of Rockville Rd., Johns Island; at The Barrows, West Branch of Cooper River, *Bragg* (M).

Hypericaceae (St. Johns-Wort Family)

ASCYRUM. St. Peters-wort.

1. Leaves distinctly clasping; inner pair of sepals nearly as long as the outer pair........ *A. stans*
1. Leaves merely sessile; inner pair of sepals minute.
   2. Blades linear-lanceolate or linear-oblanceolate, even the larger ones under 5 mm. wide, and 0.5-2 cm. long .... *A. hypericoides*
   2. Blades oblong-lanceolate or oblong-oblanceolate, the larger ones mostly 5 mm. wide or more, and 1-3 cm. long.
      3. Plants low, diffusely branched or matted; larger leaves 1-2.3 cm. long .... *A. hypericoides* var. *multicaule*

3. Plants erect or ascending, the branches mostly confined to the middle and upper portions; larger leaves 2-3 cm. long ....*A. hypericoides* var. *oblongifolium*

§ A. HYPERICOIDES L. *A. linifolium* Spach. St. Andrews-cross. — Frequent in a wide variety of habitats: shore woods, old fields, pine woods, dry sandy woods, rich moist woods, wet woods, bays, and stream banks.

§ A. HYPERICOIDES L. var. MULTICAULE (Michx.) Fern. — Frequent in pine woods, moist rich woods, and wet woods.

§ A. HYPERICOIDES L. var. OBLONGIFOLIUM (Spach) Fern. — Collected in moist rich woods; perhaps occasional or frequent but overlooked.

§ A. STANS Michx. St. Peters-wort. — Frequent in pine woods.

HYPERICUM. St. Johns-wort.

1. Flowers in a non-leafy inflorescence (a regularly branched cyme).
  2. Leaves revolute, narrowly elliptic to linear, less than 1 cm. wide ....*H. cistifolium*
  2. Leaves not revolute, elliptic to ovate-lanceolate, 1-2.5 cm. wide ....*H. nudiflorum*
1. Flowers in a leafy inflorescence.
  3. Leaves cordate-clasping, ovate to ovate-lanceolate ....(*H. myrtifolium*)
  3. Leaves more or less narrowed to the base.
    4. Cymes grouped in terminal corymbs; the opposite leaves with much smaller leaves clustered in their axils, hence the arrangement still appearing opposite .... (*H. densiflorum*)
    4. Cymes axillary; the opposite leaves with leaves at least half as long clustered in their axils, hence the arrangement appearing whorled.
      5. Larger leaves over 3 mm. wide, oblanceolate ....*H. galioides* var. *pallidum*
      5. Larger leaves under 3 mm. wide, linear or linear-spatulate.
        6. Leaves of the axillary clusters noticeably shorter than the main pair; leaves with discernible blades ....*H. galioides*
        6. Leaves of the axillary clusters scarcely shorter than the main pair; leaves needle-like.
          7. Larger leaves over 1 cm. long ....*H. galioides* var. *fasciculatum*
          7. Larger leaves under 1 cm. long ....(*H. galioides* var. *reductum*)

(Note: *H. galioides* and its varieties form a completely intergrading series.)

§ H. CISTIFOLIUM Lam. *H. opacum* T. & G., as given in Small's *Manual;* not the *H. cistifolium* of that *Manual.* — Frequent in wet pine woods.

§ H. GALIOIDES Lam. — Occasional in wet pine woods.

§ H. GALIOIDES Lam. var. FASCICULATUM (Lam.) Svenson. *H. fasciculatum* Lam. Sand-weed. — Occasional in wet pine woods.

§ H. GALIOIDES Lam. var. PALLIDUM C. Mohr. *H. ambiguum* Ell. — Frequent along stream banks and in wet woods.

§ H. NUDIFLORUM Michx. — The type of this species was collected by *Michaux* at "Goose Creek" (H. K. Svenson, Rhodora **42**:18, 1940). It is not certain that this was from our area, since in Michaux's time "Goose Creek" meant the parish of St. James' Church on Goose Creek, over half of which lay outside our area. However, Michaux's residence was near the Charleston end, and this species is admitted to the catalogue on the probability that he obtained it near home. No subsequent local collections are known to the writer.

Tamaricaceae (Tamarisk Family)

TAMARIX. Tamarisk.

§ T. GALLICA L. French Tamarisk, Salt-water-cedar. — An escape from cultivation which has long been naturalized along beach dunes and salt marsh borders.

Cistaceae (Rockrose Family)

HELIANTHEMUM. Frostweed.

In this genus, some of the flowers (petaliferous) bear large petals but shed them by mid-day, while more of the flowers (apetalous) bear minute petals or none at all. Unless good blooming specimens are keyed early in the day, it is better to rely on mature plants with well-developed capsules.

1. Plants coarsely hirsute (the hairs 1 mm. long or more) ....*H. carolinianum*
1. Plants finely tomentulose.
   2. Flowers at first petaliferous, and solitary or few; later in the season, flowers apetalous, and numerous in clusters. The mature plant has usually solitary large capsules from the petaliferous flowers, half way up the stem, and numerous smaller capsules from the apetalous flowers in groups and axillary, scattered along the upper portion of the stem ....(*H. canadense*)
   2. Flowers, both petaliferous and apetalous, in the same clusters. Hence the larger and smaller capsules occur together.
      3. Inflorescences forming narrow axillary thysoid panicles along the upper half of the stem (leaves linear or linear-lanceolate) ....(*H. rosmarinifolium*)
      3. Inflorescences typical cymes, more nearly terminal (leaves linear to oval).
         4. Cymes strictly terminal, the flowers closely grouped in each ......*H. corymbosum*
         4. Cymes terminal and lateral, the flowers loosely grouped in each .... *H. georgianum*

§ H. CAROLINIANUM (Walt.) Michx. *Crocanthemum carolinianum* (Walt.) Spach. Frostweed. — Occasional in dry soil: beach dunes, old fields, roadsides, and pine woods.

§ H. CORYMBOSUM Michx. *Crocanthemum corymbosum* (Michx.) Britton. — Collected in sandy field at Mt. Pleasant; at edge of salt marsh, Folly Island, *Dawson;* at Isle of Palms, *Robinson* (G).

§ ?H. GEORGIANUM Chapm. *Crocanthemum georgianum* (Chapm.) Barnhart. — The presence of this species in our flora is not yet certain. A specimen collected in a sandy field at Mt. Pleasant appears to be this, but lacks the developed inflorescence necessary for reliable identification.

(Mention should be made of H. ROSMARINIFOLIUM Pursh, which may presently be found within our area. It has been collected by *Godfrey* and *Tryon* 2 miles west of Rt. 17, near the south bank of the Santee, and at the Santee Canal 5 miles west of Pineville (G.)).

Cactaceae (Cactus Family)

OPUNTIA. Pricklypear.

1. Spines yellow, stout, rather flattened, abundant (plants erect, becoming several feet high) ....*O. tunoidea*
1. Spines gray, slender, terete, or else lacking.
   2. Joints small, easily detaching; spines abundant ....*O. Drummondii*
   2. Joints larger, firmly attached; spines few or lacking.
      3. Plant glaucous bluish-green; joints suborbicular ....*O. Pollardi*
      3. Plant rich or light green; joints mostly obovate or elliptic.
         4. Joints generally elongate, i. e., elliptic to narrowly oblong, and very thick compared to width ....*O. macrarthra*
         4. Joints generally obovate, i. e., little longer than wide, and not conspicuously thick ....(*O. humifusa*)

§ O. DRUMMONDII Graham. *O. Pes-Corvi* Le Conte. *O. frustulenta* Gibbes. Pricklypear. — Common on beach dunes; frequent at salt marsh borders and in sandy fields; occasional in shore woods, dry sandy woods, and on stream bluffs.

§ O. MACRARTHRA Gibbes. Pricklypear. — Frequent on beach dunes, along salt marsh borders, in sandy fields, and dry sandy woods.

"Gibbes" refers to Professor Lewis R. Gibbes of the College of Charleston, who was the first to realize the existence of four *Opuntia* species here (Proc. Ell. Soc. Nat. Hist. **1**:272-273, 1858).

The collections from our area labeled *O. humifera* Raf. (*O. vulgaris* Mill., *O. Opuntia* (L.) Karst.) all appear to be *O. macrarthra* or *O. Pollardi*.

§ O. POLLARDI Britton & Rose. Pricklypear. — Collected at sandy roadside, Rockville Rd., 1.7 miles beyond Martin's Point Rd., Wadmalaw Island; on bluff at Old Town; at Mt. Pleasant, *Small* (NY).

§ O. TUNOIDEA Gibbes. *O. Dillenii* (Ker) Haw. Pricklypear. — Occasionally found persisting after cultivation. Collected on sand dunes at Rockville, *Small* (NY).

Lythraceae (Loosestrife Family)

DECODON. Swamp-loosestrife.

§ D. VERTICILLATUS (L.) Ell. Swamp-loosestrife. — Occasional in bays, wet woods, and aquatic habitats.

LAGERSTROEMIA.

§ L. INDICA L. Crapemyrtle. — This famous ornamental was introduced to Charleston by Michaux (the younger?) who distributed it liberally to the planters. Shoots are again sprouting from the old roots in the Michaux Garden despite the Army's thorough work of clearing.

Araliaceae (Ginseng Family)

ARALIA.

§ A. SPINOSA L. Devils-walkingstick. — Common in moist rich woods; occasional in pine woods, dry sandy woods, and wet woods.

HEDERA. Ivy.

§ H. HELIX L. English Ivy. — Occasionally spreading from cultivation.

Cornaceae (Dogwood Family)

CORNUS. Dogwood.

1. Leaves alternate (usually crowded toward the ends of the twigs) ....(*C. alternifolia*)
1. Leaves opposite.
    2. Blades oval to elliptic, less frequently ovate; twigs curved; fruits red; inflorescences compact, surrounded by four conspicuous white petaloid bracts .... *C. florida*
    2. Blades ovate to lanceolate, less frequently elliptic; twigs straight; fruits blue; inflorescences spreading, without bracts.
        3. Pith brown; branchlets purple .... *C. Amomum*
        3. Pith white; branchlets green or brown.
            4. Twigs glabrous; leaves smooth to the touch .... *C. stricta*
            4. Twigs pubescent; leaves rough to the touch .... *C. asperifolia*

§ C. AMOMUM Mill. *Svida Amomum* (Mill.) Small. Silky Dogwood. — Collected at Michaux Garden, *Auld, Bragg, Clement, Dawson, Hoch, Hunt, Peacock*.

§ C. ASPERIFOLIA Michx. *C. microcarpa* Nash. *Svida microcarpa* (Nash) Small. Not the *C. asperifolia* of authors nor the *Svida asperifolia* of Small's *Manual*. — Collected in moist rich woods on Northampton Rd. at Harleston Dam Creek; and on slope by Ashley River just west of Fort Dorchester. Has also been collected at the Santee Canal, outside our area, by *Ravenel* (M).

H. W. Rickett has shown (Amer. Midl. Nat. **27**:259-261, 1942) that our southeastern species is distinct from the midwestern one to which Michaux's name has long been misapplied.

§ C. FLORIDA L. *Cynoxylon floridum* (L.) Raf. Flowering Dogwood. — Common in moist rich woods; occasional in dry sandy woods and pine woods.

§ C. STRICTA Lam. *Svida stricta* (Lam.) Small. *Cornus foemina* Mill. in part. Stiff Cornel. — Common in wet woods and along stream banks; frequent in moist rich woods.

NYSSA. Tupelo.

1. Leaf of a large type, the length of blade multiplied by the width averaging 60 sq. cm. or more; fruit 2.5-4 cm. long.
  2. Apex acute or acuminate; fruit dark purple .... *N. aquatica*
  2. Apex rounded and mucronate; fruit red .... (*N. Ogeche*)
1. Leaf of a medium type, the length of blade multiplied by the width averaging 50 sq. cm. or less; fruit 1-1.5 cm. long.
  3. Blades broadly oval or short-oblong (blades thick, often pubescent beneath) .... *N. sylvatica* var. *dilatata*
  3. Blades obovate, elliptic, or oblanceolate (blades thick or thin, glabrous or nearly so beneath).
    4. Leaf-blades typically obovate to elliptic, though varying to oblanceolate; apex usually abruptly pointed (margins sometimes with a few remote teeth; blades thin) .... *N. sylvatica*
    4. Leaf-blades typically oblanceolate to elliptic, prevailingly narrow; apex usually acute or obtuse (margins always entire; blades somewhat thicker) .... *N. sylvatica* var. *biflora*

§ N. AQUATICA L. Water Tupelo. — Confined to cypress swamps, but common there. Rickett reports (North Amer. Flora **28B**: Part 2, p. 315) that this name refers to a mixture of plants and must be regarded as a *nomen confusum*. In this case the correct name would become *N. uniflora* Wangh.

§ N. SYLVATICA Marsh. Blackgum. — Common in moist rich woods; frequent in old fields, pine woods, dry sandy woods, and along stream banks; occasional in bays and wet woods.

§ N. SYLVATICA Marsh. var. BIFLORA (Walt.) Sarg. *N. biflora* Walt. Blackgum. — Frequent in cypress swamps, wet woods, moist rich woods, bays, and along stream banks and the edges of pineland ponds.

§ N. SYLVATICA Marsh. var. DILATATA Fern. — Occasional in dry sandy woods.

Rickett suggests that this might be found to be a hybrid of "*N. sylvatica* × *N. biflora*."

Ericaceae (Heath Family)

CHIMAPHILA. Pipsissewa.

§ C. MACULATA (L.) Pursh. Spotted-wintergreen. — Frequent in moist rich woods.

CLETHRA. White-alder.

1. Leaves glabrous beneath except along the veins .... (*C. alnifolia*)
1. Leaves evenly short-tomentose beneath .... *C. tomentosa*

§ C. TOMENTOSA Lam. Sweet-pepperbush. — Common in pine woods and bays; frequent in old fields, dry sandy woods, and moist rich woods; occasional in wet woods.

GAYLUSSACIA. Huckleberry.

1. Blades oblanceolate; bracts of inflorescence persistent; fruit black, shining .... *G. dumosa*
1. Blades obovate or elliptic; bracts of inflorescence deciduous; fruit glaucous-blue, dull .... *G. frondosa*

§ G. DUMOSA (Andr.) T. & G. *Lasiococcus dumosus* (Andr.) Small. Dwarf Huckleberry. — Frequent in pine woods and dry sandy woods.

§ G. FRONDOSA (L.) T. & G. *Decachaena frondosa* (L.) T. & G. — Dangleberry. — Common in pine woods and bays; occasional in dry sandy woods, moist rich woods, and wet woods.

KALMIA. Laurel.

1. Petioles lacking, or obscured by the long-cuneate leaf bases.
   2. Blades 1 cm. long or less, their bases acute .... *K. hirsuta*
   2. Blades 2 cm. long or more, their bases long-cuneate .... (*K. cuneata*)
1. Petioles distinctly present.
   3. Leaves glabrous, mostly alternate; blades averaging over 5 cm. long; inflorescences terminal .... (*K. latifolia*)
   3. Leaves finely pubescent beneath, mostly opposite or whorled; blades averaging under 5 cm. long; inflorescences lateral .... (*K. carolina*)

§ K. HIRSUTA Walt. *Kalmiella hirsuta* (Walt.) Small. Wicky. — Collected in pine woods by A. C. L. R. R., ½ mile west of New Rd. Also reported by *Bachman*.

LEUCOTHOE. Fetter-bush.

1. Leaves deciduous .... *L. racemosa*
1. Leaves persistent.
   2. Blades elliptic or elliptic-lanceolate; racemes sessile .... *L. axillaris*
   2. Blades lanceolate or ovate-lanceolate; racemes peduncled .... *L. populifolia*

§ L. AXILLARIS (Lam.) Dipp. Fetter-bush. — Collected on stream bank, Daisy Swamp, ½ mile north of Rt. 2; at Summerville, *Robinson* (G), *Bragg* (M) and *Fox* (M).

§ L. POPULIFOLIA (Lam.) Dipp. *L. acuminata* (Ait.) D. Don. Fetter-bush. — Collected in St. Andrew's Parish, *Sheridan* (M); at Horts, the Ball estate on the East Branch of the Cooper River (not the "Ashley River" as labeled), *Sargent* (AA).

§ L. RACEMOSA (L.) Gray. *Eubotrys racemosa* (L.) Nutt. Fetter-bush. — Frequent in pine woods; occasional in moist rich woods, bays, seepage slopes, wet woods, and cypress swamps.

Fernald designates two varieties of this, which may be differentiated, as follows:

1. Inflorescence under 7 cm. long .... *L. racemosa* (L.) Gray
1. Inflorescence over 7 cm. long.
   2. Rachis and pedicels of inflorescence minutely pilose .... *L. racemosa* (L.) Gray var. *elongata* (Small) Fern.
   2. Rachis and pedicels of inflorescence glabrous .... *L. racemosa* (L.) Gray var. *projecta* Fern.

In our area the inflorescences seem to vary in length on the same shrub and at different seasons. All show some degree of pubescence under sufficient magnification.

LYONIA.

1. Leaves persistent.
   2. Twigs triangular, due to decurrent leaf-scars; leaves glabrous .... *L. lucida*
   2. Twigs terete; leaves scaly-coated beneath.
      3. Leaves slightly reduced toward the ends of the branches .... (*L. ferruginea*)
      3. Leaves much reduced toward the ends of the branches .... (*L. ferruginea* var. *fruticosa*)
1. Leaves deciduous.

4. Buds divaricate, short-conic; blades entire; capsules pear-shaped, 5-8 mm. long; corolla 1 cm. long .... *L. mariana*

4. Buds appressed, slender; blades mostly serrulate; capsules globose, 3-4 mm. long; corolla 3-4 mm. long.

5. Panicles mostly without leafy bracts along their branches (an occasional branch may have one or two bracts) .... *L. ligustrina*

5. Panicles with leafy bracts along their branches.

6. Twigs and fruits almost completely glabrous; blades smooth-surfaced, shining, lance-elliptic, long-acuminate; panicle exceedingly diffuse and leafy .... *L. ligustrina* var. *salicifolia*

6. Twigs and fruits minutely pubescent; blades slightly rugose, dull, oblong to obovate, round-tipped to acute; panicle more compact.

7. Blades thinly appressed-pubescent beneath .... *L. ligustrina* var. *foliosiflora*

7. Blades closely tomentulose beneath .... *L. ligustrina* var. *pubescens*

§ L. LIGUSTRINA (L.) DC. *Arsenococcus ligustrinus* (L.) Small. Male-berry. — Frequent in pine woods and bays; occasional on seepage slopes.

Many intermediate conditions exist between this and the following varieties. The range of variation within this species is so great, however, that some manner of subdivision seems necessary.

§ L. LIGUSTRINA (L.) DC. var. FOLIOSIFLORA (Michx.) Fern. *Arsenococcus frondosus* (Pursh) Small. Male-berry. — Frequent in pine woods and bays.

§ L. LIGUSTRINA (L.) DC. var. PUBESCENS (Gray) Rehder. — Collected in Summerville, ... (M). A specimen from "St. John's Berkeley" (parish) *Wallace* (M) is probably from outside our area, as is also the collection 6 miles northwest of McClellanville, *Godfrey* and *Tryon* (G).

§ L. LIGUSTRINA (L.) DC. var. SALICIFOLIA (Wats.) DC. — Collected at edge of pond in sandy pineland, Northampton Rd., 1/4 mile north of Halfway Creek Rd. (Deposited at the Gray Herbarium.)

§ L. LUCIDA (Lam.) K. Koch. *Desmothamnus lucidus* (Lam.) Small. Fetter-bush. — Common in bays; frequent in pine woods, moist rich woods, on seepage slopes, and along stream banks.

§ L. MARIANA (L.) D. Don. *Neopieris mariana* (L.) Britton. Stagger-bush. — Common in pine woods; frequent in bays; occasional in dry sandy woods.

RHODODENDRON. Azalea.

1. Shrub usually under 0.5 m. tall, the stems scarcely branched, arising over a wide area from stolons (flowers appearing before or with the leaves) .... *R. atlanticum*

1. Shrub usually over 0.5 m. tall, the stems repeatedly branched, with stolons lacking or limited in extent.

2. Pubescence gray-tomentose toward the end of the twigs; blades evenly pubescent beneath; flowers appearing before or with the leaves; corolla tube pubescent inside .... *R. canescens*

2. Pubescence brown-strigose toward the ends of the twigs; blades pubescent beneath on veins only; flowers appearing after the leaves; corolla tube glabrous inside.

3. Bark of twigs pale yellow-brown; bud scales less than 15, obtuse, mucronate .... *R. viscosum*

3. Bark of twigs rich red-brown; bud scales 15 or more, aristate .... *R. serrulatum*

§ R. ATLANTICUM (Ashe) Rehder. *Azalea atlantica* Ashe. — Occasional in pine woods, dry sandy woods, and savannas.

This species varies in color from white to rose purple. Several varieties have been described on the basis of flower-color, but they integrade so much that I am following Fernald (Rhodora **43**: 619-624, 1941) in regarding them as forms. The most frequent of these in our area seems to be the one that W. C. Coker named *Azalea altantica* Ashe var. *luteo-alba*, having white flowers tinged with yellow (Jour. Elisha Mitchell Sci. Soc. **36**:98, 1920).

§ R. CANESCENS (Michx.) Sweet. *Azalea canescens* Michx. Wild Azalea, Swamp-honeysuckle. — Common in moist rich woods; frequent in dry sandy woods.

§ R. SERRULATUM (Small) Millais. *Azalea serrulata* Small. — Collected in long-leaf pineland, east of Witherbee, *Guerard*.

§ R. VISCOSUM (L.) Torr. *Azalea viscosa* L. Swamp Azalea. — Frequent in pine woods; occasional in bays and on seepage slopes.

VACCINIUM. Blueberry.

The interpretation here is adapted from that of W. H. Camp in *The North American blueberries, with notes on other groups of Vacciniaceae*, Brittonia **5**:203-275, 1945. This carries references to Camp's other papers on *Vaccinium* and speciation. Using the methods of biosystematy, Camp traces a spectacular development of hybrids and polyploids which followed the meeting of northern and southern populations on the emerging Southeastern Coastal Plain. Several fairly stable species have developed from the new combinations, but hybrids continue to be abundant, and polyploids apparently still are being produced. Some of the latter differ primarily in size characters only, causing difficulty to the student who finds specimens near the common limit of variability. Yet by reference to the paper cited above, it is usually possible to place a blueberry where it belongs or to discover the probable parentage.

In the following key, the portion dealing with the subgenus *Cyanococcus* follows the work of Camp. The subgenus *Polycodium*, which has not yet been similarly investigated, is based partly upon the treatment in Small's *Manual*. Specimens which the key fails to accommodate might be sent to W. H. Camp, New York Botanical Garden, New York 58, N. Y. It is important to report the height and habit of the plant and color of flower or fruit.

1. Plant a shrub or small tree, stiffly much-branched, with rigid, hard red-brown twigs; blades thick, lustrous, broadly oval or short-obovate .... *V. arboreum*

1. Plant a shrub with flexuous, greenish or red-tinted twigs; blades various, if lustrous the plant under 6 dm. tall.
   2. Leaves persistent.
      3. Stems trailing and rooting .... *V. crassifolium*
      3. Stems upright or at least ascending at the ends .... (*V. Myrsinites*)
   2. Leaves deciduous.
      4. Twigs not white-speckled or pebbly; bracts of the inflorescence leafy, usually persistent; pedicels about 1 cm. long, flexuous, drooping: subgenus *Polycodium*.
         5. Bracts of the inflorescence about as large as the leaves .... (*V. caesium*)
         5. Bracts of the inflorescence conspicuously smaller than the leaves.
            6. Blades ovate to obovate (pubescent to glabrous beneath); berry glabrous, green or yellow at maturity .... *V. stamineum*
            6. Blades elliptic or lanceolate to oblanceolate (pubescent beneath); berry pubescent when young, purple or black at maturity ....(*V. melanocarpum*)
      4. Twigs white-speckled or pebbly; bracts of the inflorescence small, early-deciduous; pedicels under 1 cm. long, stiff: subgenus *Cyanococcus*.
         7. Plants not over 1 m. high; blades typically narrow, and broadest above the middle; lower leaf surface with minute glandular, i. e., brown-tipped, hairs (see also *V. amoenum* and *V. Ashei*.)

8. Blades 2-3.5 cm. long; corolla 4-6 mm. long; plants 0.15-0.4 m. high .... *V. tenellum*

8. Blades 3-4.5 cm. long; corolla 6-10 mm. long; plants 0.5-1 m. high........ *V. virgatum*

7. Plants over 1 m. high; blades typically elliptic or else broadest below the middle, except in *V. amoenum;* lower leaf surface without glandular hairs, except in *V. amoenum* and *V. Ashei.*

9. Blades 1-3 cm. long (margins serrate) .... *V. Elliottii*

9. Blades 3-8 cm. long.

10. Leaf margins more or less serrate; lower leaf surface with minute glandular hairs (corolla 8-12 mm. long).

11. Margins sharply serrate; blades 4-5 cm. long, mostly obovate; glandular hairs abundant .... *V. amoenum*

11. Margins almost entire; blades 4-8 cm. long, mostly elliptic; glandular hairs scattered or rare .... *V. Ashei*

10. Leaf margins entire; lower leaf surface non-glandular (corolla 5-11 mm. long).

12. Blades glabrous.

13. Plants 1.5-2 m. high; blades 3-5 cm. long; corolla 5-6 mm. long .... *V. caesariense*

13. Plants 2-5 m. high; blades 5-8 cm. long; corolla 8-11 mm. long .... *V. australe*

12. Blades pubescent.

14. Plants 1.5-2.5 m. high; blades 3-6 cm. long; corolla 5-6 mm. long .... *V. atrococcum*

14. Plants 2-4 m. high; blades 5-8 cm. long; corolla 6-9 mm. long .... *V. marianum*

§ V. AMOENUM Ait. *Cyanococcus amoenus* (Ait.) Small, in part. Large Cluster Blueberry, "Tall-huckleberry." — Collected at edge of wet woods, Parker's Ferry Rd., 2½ miles west of Savannah Rd., *Auld, Barrington, Dawson, Horlbeck, Hunt, Peacock, Rogers.*

A hybrid, *V. amoenum* × *V. Ashei*, was collected in wet woods on Bulow Mines Rd., 1 mile north of Bee's Ferry Rd.

§ V. ARBOREUM Marsh. *Batodendron arboreum* (Marsh.) Nutt. Tree Sparkleberry. — Common in dry sandy woods and pine woods; frequent in moist rich woods; occasional in shore woods and along stream banks.

§ V. ASHEI Reade. *Cyanococcus amoenus* (Ait.) Small, and *C. corymbosus* (Gray) Small, of Small's *Manual*, in part. *V. virgatum* Ait. as given in Rehder's *Manual*, in part. Rabbiteye Blueberry. — Frequent in moist rich woods; occasional in wet woods.

§ V. ATROCOCCUM (Gray) Heller. *Cyanococcus atrococcus* (Gray) Small, in part. Black Highbush Blueberry. — Frequent in wet pine woods and savannas; occasional in wet woods.

Two hybrids of this have been collected, *V. atrococcum* × *V. Elliottii* in wet pineland ¾ mile southwest of Middleton Gardens, and *V. atrococcum* × *V. caesariense* in moist rich woods ½ mile southwest of Middleton Gardens.

§ V. AUSTRALE Small. *Cyanococcus virgatus* (Ait.) Small, in part. Highbush Blueberry. — Frequent in pine woods and bays; occasional in wet woods.

§ V. CAESARIENSE Mack. *Cyanococcus liparus* Small, in part. High-bush Blueberry. — Collected in wet woods, Caw Caw Swamp Rd., 1½ miles south of Warren Crossroad, *Martin* and *Hunt.*

§ V. CRASSIFOLIUM Andr. *Herpothamnus crassifolius* (Andr.) Small. Creeping Blueberry. — Frequent in pine woods and bays.

§ V. ELLIOTTII Chapm. *Cyanococcus Elliottii* (Chapm.) Small. Mayberry. — Fre- moist rich woods 1/8 mile southwest of Middleton Gardens.

A hybrid, *V. Elliottii* × *V. tenellum* (*Cyanococcus Cuthbertii* Small, in part), has been collected in wet woods by the Ashley River at Slann's Bridge.

§ ?V. MARIANUM Wats. Highbush Blueberry. — I am doubtfully placing here a single specimen collected in wet pineland 3/4 mile southwest of Middleton Gardens.

§ V. STAMINEUM L. *Polycodium stamineum* (L.) Greene. Deerberry. — Frequent in dry sandy woods; occasional in pine woods and moist rich woods.

§ V. TENELLUM Ait. *V. virgatum* Ait. var. *tenellum* (Ait) Gray. *Cyanococcus tenellus* (Ait.) Small. Small Cluster Blueberry; "Low-huckleberry." — Common in pine woods and dry sandy woods; occasional in moist rich woods and bays.

§ V. VIRGATUM Ait. *Cyanococcus virgatum* (Ait.) Small, in part. Medium Cluster Blueberry; "Huckleberry." — Frequent in dry sandy woods; occasional in pine woods and moist rich woods.

ZENOBIA.

§ Z. PULVERULENTA (Bartr.) Pollard. — Collected at edge of pineland pond, Northampton Rd., 1/4 mile north of Half-way Creek Rd., *Duncan*, *Martin*, and *Hunt*; also in shrub-bog, Conifer Rd., 3/4 mile north of Half-way Creek Rd., *Martin* and *Hunt*.

The non-glaucous plant which has been recognized as *Z. cassinefolia* (Vent.) Pollard and *Z. pulverulenta* (Bartr.) Pollard var. *nuda* (Vent.) Rehder is apparently but a form of this species, and has been so designated by Fernald. Both types of leaves have been collected here on the same shrub.

Sapotaceae (Sapodilla Family)

BUMELIA. Bumelia.

1. Blades glabrous beneath .... *B. lycioides*
1. Blades copiously pubescent beneath.
    2. Pubescence silky, lustrous .... *B. tenax*
    2. Pubescence woolly, not at all lustrous .... (*B. lanuginosa*)

§ B. LYCIOIDES (L.) Pers. Buckthorn Bumelia. — Occasional on slopes in moist rich or dry sandy woods.

§ B. TENAX (L.) Willd. Tough Bumelia. — Occasional in shore woods and dry sandy woods.

Ebenaceae (Ebony Family)

DIOSPYROS. Persimmon.

§ D. VIRGINIANA L. Common Persimmon. — Common in moist rich woods and pine woods; frequent in dry sandy woods and wet woods; occasional in shore woods, old fields, and along stream banks.

A pubescent-leaved form, which has been designated *D. virginiana* var. *pubescens* (Pursh) Dipp., is occasionally found here.

Symplocaceae (Sweetleaf Family)

SYMPLOCOS. Sweetleaf.

§ S. TINCTORIA (Garden) L'Herit. Common Sweetleaf, Horse-sugar. — Common in moist rich woods; frequent in pine woods; occasional in wet woods and dry sandy woods.

Styracaceae (Storax Family)

HALESIA. Silverbell.

1. Blades serrulate; fruit four-winged.
   2. Surface of blades pubescent above and densely villous or tomentose beneath (tips rather long-acuminate) .... *H. carolina* var. *mollis*
   2. Surface of blades tomentose when unfolding but soon glabrous throughout (tips more abruptly acuminate) .... *H. carolina*
1. Blades remotely serrate; fruit two-winged .... (*H. diptera*)

§ H. CAROLINA Ellis. Carolina Silverbell. — Collected in moist rich woods sloping to creek, east of Highland Park, 11 miles north of Charleston. Also reported by *Bachman.*

§ H. CAROLINA Ellis var. MOLLIS (Lange) Perkins. — Collected on seepage slope by salt marsh, LaRoche property, ¼ mile west of junction of Chisholm and Humbert Rds., Johns Island, *Martin* and *Hunt.*

STYRAX. Snowbell.

1. Blades becoming broader, i. e., orbicular-obovate, toward the ends of the twigs; flowers in racemes which are leafy only at the basal half (blades usually densely white-tomentose beneath) .... *S. grandifolia*
1. Blades of comparable shape, i. e., mostly oval, throughout the length of the twig; flowers in racemes or panicles which are leafy throughout their length.
   2. Lower surface of blades glabrous or nearly so .... *S. americana*
   2. Lower surface of blades densely pubescent .... *S. americana* var. *pulverulenta*

§ S. AMERICANA Lam. Snowbell, Styrax. — Common in wet woods; frequent in cypress swamps and along stream banks.

§ S. AMERICANA Lam. var. PULVERULENTA (Michx.) Perk. — Collected in cypress swamp in Caw Caw Swamp south of Moberry Rd.; in moist rich woods on Bee's Ferry Rd., 2 miles from Ashley River Rd.; in woods back of Goose Creek Church, Otranto, *Bragg* (M.).

§ S. GRANDIFOLIA Ait. Bigleaf Snowbell. — Collected in sloping rich woods, southeast of Fenwick Two-mile Heat section of Rockville Rd., Johns Island; in moist rich woods, Bee's Ferry Rd., 2 miles from Ashley River Rd.; in pine woods, Martin's Point Rd., Wadmalaw Island, *Horlbeck.*

Oleaceae (Olive Family)

CHIONANTHUS. Fringetree.

§ C. VIRGINICUS L. Fringetree. — Occasional in moist rich woods, pine woods, dry sandy woods, and seepage slopes.

FRAXINUS. Ash.

For reliable identification in this genus the fruit is required, as the vegetative characters are variable and often fail to hold.

1. Top of leaf-scars mostly straight, or with only a slight bud notch; scars usually longer than broad; terminal buds long-pointed; body of fruit terete but narrowly linear.
   2. Twigs glabrous .... *F. pennsylvanica* var. *lanceolata*
   2. Twigs pubescent .... (*F. pennsylvanica*)
1. Top of leaf-scars mostly concave; scars usually broader than long; terminal buds short-pointed or domed; body of fruit flattened, or if terete, then plump, fusiform.
   3. Leaflets 5 or 7, with equal frequency, varying from lanceolate to elliptic or short-oval, often rounded at the apex; body of fruit flat, enveloped to the base by the broad wing.

4. Twigs glabrous .... *F. caroliniana*
4. Twigs pubescent .... (*F. caroliniana* var. *pubescens*)

3. Leaflets mostly 7, occasionally 5 or 9, generally ovate, quite regularly acuminate at the apex; body of fruit terete.

5. Terminal buds acute; wing of fruit decurrent to the middle or nearly to the base of the body.

6. Twigs glabrous .... *F. tomentosa*, var.
6. Twigs pubescent .... *F. tomentosa*

5. Terminal buds domed; wing of fruit not or scarcely decurrent on the body.

7. Twigs glabrous .... *F. americana*
7. Twigs pubescent .... (*F. biltmoreana*)

§ F. AMERICANA L. White Ash. — Collected by creek in Michaux Garden, *Auld, Bragg, Clement, Dawson, Hoch, Hunt, Peacock*.

§ F. CAROLINIANA Mill. Carolina Ash. — Common in cypress swamps; frequent in wet woods and along streams.

§ F. PENNSYLVANICA Marsh. var. LANCEOLATA (Borkh.) Sarg. Green Ash. — Collected in wet woods, south of Ashley River Rd. near Ashley Hall Rd.; also in wet woods, Bee's Ferry Rd., 2¼ miles from Ashley River Rd.

§ F. TOMENTOSA Michx. f. *F. profunda* Bush. *F. Michauxii* Britton. — Collected in wet woods at edge of cypress swamp, south of Schultz Lake, upper Ashley River.

A variety of this with glabrous branchlets and buds, which was distinguished by E. J. Palmer as *F. profunda* Bush var. *Ashei*, is frequent here in moist rich woods and occasional in wet woods.

LIGUSTRUM. Privet.

1. Leaves persistent; a tree (blades and twigs glabrous) .... (*L. lucidum*)
1. Leaves deciduous or tardily so; a shrub or small tree.

2. Blades thick, glabrous; twigs puberulent .... (*L. vulgare*)
2. Blades thin, pubescent on midrib beneath; twigs densely pubescent .... *L. sinense*

§ L. SINENSE Lour. Chinese Privet. — Occasional, as an escape from cultivation.

OSMANTHUS. Wild-olive. American-olive.

§ O. AMERICANUS (L.) Benth. & Hook. *Amarolea americana* (L.) Small. Devilwood. — Frequent in shore woods, moist rich woods, and dry sandy woods; occasional in pine woods and along stream banks.

Loganiaceae (Logania Family)

GELSEMIUM. Yellow Jessamine.

1. Leaf base acute to nearly rounded; capsule short-beaked; seed winged; flowers fragrant .... *G. sempervirens*
1. Leaf base rounded; capsule long-beaked; seed wingless; flowers without odor .... (*G. Rankinii*)

§ G. SEMPERVIRENS (L.) Ait. Carolina Yellow Jessamine. — Common in moist rich woods, pine woods, dry sandy woods, wet woods, and along stream banks; occasional in old fields and bays.

Apocynaceae (Dogbane Family)

TRACHELOSPERMUM.

§ T. DIFFORME (Walt.) A. Gray. — Frequent in wet woods and along stream banks.

Verbenaceae (Verbena Family)

CALLICARPA. Beauty-berry.

§ C. AMERICANA L. French-mulberry. — Common in moist rich woods; frequent in shore woods and wet woods; occasional in pine woods, dry sandy woods, and along stream banks.

LANTANA. Lantana.

§ L. CAMARA L. Lantana. — Frequent as an escape from cultivation in vacant lots, roadsides, and old fields.

Solanaceae (Nightshade Family)

SOLANUM. Nightshade.

S. ACULEATISSIMUM Jacq. Soda-apple. — Collected on sandy stream bank, east of Caw Caw Swamp Rd. near Warren Crossroad, *Martin* and *Hunt*.

Bignoniaceae (Bignonia Family)

BIGNONIA.

§ B. CAPREOLATA L. *Anisostichus crucigera* (L.) Bureau. Cross-vine. — Common in moist rich woods and wet woods; frequent along stream banks; occasional in pine woods.

CAMPSIS. Trumpet-creeper.

§ C. RADICANS (L.) Seem. *Bignonia radicans* L. Trumpet-vine. — Common in old fields, along roadsides, and in wet woods; frequent in moist rich woods and along stream banks; occasional in shore woods, pine woods, and dry sandy woods.

CATALPA. Catalpa.

§ C. BIGNONIOIDES Walt. C. *Catalpa* (L.) Karst. Southern Catalpa, Catawba. — Frequent along roadsides and in old fields and homesteads, as an escape from cultivation.

Rubiaceae (Madder Family)

CEPHALANTHUS. Buttonbush.

§ C. OCCIDENTALIS L. Common Buttonbush. — Common in wet woods and edges of ponds and fresh water marshes; frequent along roadside ditches, stream banks, in bays and cypress swamps.

MITCHELLA. Partridge-berry.

M. REPENS L. Partridge-berry. — Common in moist rich woods; occasional in dry sandy woods, pine woods, and along stream banks.

PINCKNEYA. Fever-bark.

§ P. PUBENS Michx. Fever-bark. — Collected at Michaux Garden, *Auld, Bragg, Clement, Dawson, Hoch, Hunt, Peacock*. A single plant was found in the wet woods by the creek. It had four stems, of which one was dying. The largest is some 25 feet high and 3 inches in diameter. It had abundant capsules and seeds, but no seedlings were found. Several new shoots, however,were arising from the roots. Since *Pinckneya* is usually shrubby, or but a small tree, it is probable that this one was actually planted by Michaux, in which case it should not be listed as belonging in our flora. Yet it certainly deserves mention. Michaux named this monotypic genus for his famous contemporary of Charleston, General Charles Cotesworth Pinckney.

J. H. Hoch of the Medical College has called to the writer's attention the following item from *Elements of Materia Medica*, by H. R. Frost, Charleston, 1843: "[the] specimen I show you was obtained about 12 miles from Charleston where it was planted by Michaux in a garden formerly cultivated by him." *Pinckneya pubens* is also reported by *Bachman*, but without comment.

The bark of *Pinckneya* was used in the Confederacy for the treatment of malaria, as it was thought to share some of the effectiveness of the related *Cinchona*.

Caprifoliaceae (Honeysuckle Family)

LONICERA. Honeysuckle.

1. Twigs pubescent, at least near the ends; leaves acute at tip, not glaucous beneath, not connate-perfoliate; flowers yellow; fruit black .... *L. japonica*
1. Twigs glabrous; leaves blunt at tip, glaucous beneath, the terimnal pair often connate-perfoliate; flowers red; fruit red .... *L. sempervirens*

§ L. JAPONICA Thunb. *Nintooa japonica* (Thunb.) Sweet. Japanese Honeysuckle. — Common in old fields and along roadsides; frequent in moist rich woods, wet woods, and along stream banks.

§ L. SEMPERVIRENS L. *Phenianthus sempervirens* (L.) Raf. Trumpet Honeysuckle, Woodbine. — Frequent in moist rich woods and wet woods; occasional in shore woods.

SAMBUCUS. Elder.

§ S. CANADENSIS L. American Elder. — Common along ditches in old fields and by roadsides; frequent in fresh water marshes, moist rich woods, and wet woods.

VIBURNUM. Arrow-wood.

1. Buds imbricate; veins terminating in the prominent coarse teeth .... *V. dentatum* var. *pubescens*
1. Buds valvate; veins anastomosing near the finely serrate, wavy, or entire margin.
    2. Blades oblanceolate, cuneate; petiole indistinct from blade, together averaging under 4.5 cm. long .... *V. obovatum*
    2. Blades elliptic or oval; petioles distinct from blade, together averaging over 4.5 cm. long.
        3. Margins entire to roughly wavy; terminal buds narrow, over 6 cm. long; cyme peduncled; twigs flexuous, ascending .... *V. nudum*
        3. Margins sharply serrulate; terminal buds under 6 cm. long; cyme sessile; twigs short, stiff, nearly at right angles to the stem.
            4. Blades very glossy; buds rusty, rounded; fruits blue .... (*V. rufidulum*)
            4. Blades rather dull; buds nearly gray, pointed; fruits black .... *V. prunifolium*

§ V. DENTATUM L. var. PUBESCENS Ait. *V. pubsecens* (Ait.) Pursh. *V. semitomentosum* as given in Small's *Manual*. Arrow-wood. — Common in wet woods; frequent in moist rich woods; occasional in cypress swamps and along stream banks.

Fernald (Rhodora **43**:647-652, 1941) considers the varietal designation unnecessary, regarding this as true *V. dentatum* L. Concerning *V. semitomentosum* (Michx.) Rehder (or *V. dentatum* L. var. *semitomentosum* Michx.), H. K. Svenson says "no one yet knows what [Michaux's] plant may be."

§ V. NUDUM L. Possum-haw. — Common in wet slopes; frequent in moist rich woods and on seepage slopes; occasional in bays.

§ V. OBOVATUM Walt. Small Viburnum. — Frequent along stream banks; occasional in wet woods.

§ V. PRUNIFOLIUM L. Blackhaw. — Frequent in moist rich woods, wet woods, and along stream banks.

Compositae (Composite Family)

ASTER. Aster.

§ A. CAROLINIANUS Walt. Shrubby Aster. — Occasional along stream banks and the edges of fresh water marshes.

BACCHARIS.

1. Blades narrowly linear .... *B. angustifolia*
1. Blades mostly obovate.
  2. Teeth or lobes of leaves often acute but not apiculate; heads in peduncled panicled clusters at the ends of the branches .... *B. halimifolia*
  2. Teeth or lobes of leaves sharply apiculate; heads in nearly sessile axillary clusters .... *B. glomeruliflora*

§ B. ANGUSTIFOLIA Michx. False-willow. — Frequent along salt marsh borders.

§ B. GLOMERULIFLORA Pers. Southern Baccharis. — Frequent in wet woods; occasional in moist rich woods and along stream banks.

§ B. HALIMIFOLIA L. Salt-water-myrtle. — Common at salt marsh borders; frequent in shore woods and old fields; occasional in wet woods, moist rich woods, pine woods, and along stream banks.

BORRICHIA. Sea-ox-eye.

§ B. FRUTESCENS (L.) DC. Sea-ox-eye. — Common and continuous along salt marsh borders; occasional on beach dunes.

IVA. Marsh-elder.

1. Margins of blades coarsely toothed .... *I. frutescens*
1. Margins of blades entire or nearly so .... *I. imbricata*

§ I. FRUTESCENS L. Marsh-elder. — Common at salt marsh borders.

§ I. IMBRICATA Walt. — Occasional on beach dunes.

Glossary

Acaulescent. Without a visible stem.
Achene. A small, dry, hard, indehiscent, one-seeded fruit, from a simple pistil.
Acicular. Needle-shaped.
Acuminate. Tapering to a long point, the sides concave near the point.
Acute. Sharp-pointed, but the sides near the point not concave; also not so narrow as cuneate.
Adnate. Union of two different organs.
Alternate. One at a node (of leaves, buds, or twigs).
Anastomosing. Veins forming a network.
Apiculate. Contracted into a minute point, but less abruptly so than mucronate.
Appressed. Lying close and flat against.
Aristate. Awned: tipped by a bristle.
Ascendant. Curving upward.
Attenuate. Slenderly tapering.
Auriculate. With ear-like appendages.
Axil. The upper angle formed by the junction of petiole and twig; also here used for the upper angle between lateral vein and midrib.

Berry. A fruit entirely fleshy and soft except for the seeds.
Biennial. Of two year's duration.
Bipinnate. Twice pinnate: the primary segments themselves separated into secondary segments.
Blade. The expanded part of a leaf: the leaf minus the petiole.
Bract. A modified, reduced leaf, usually associated with the inflorescence, or sometimes at the base of a shoot or needle-cluster.
Branchlet. Here used for a small branch more than one year old.
Bundle-scars. Scars formed in a leaf-scar by the breaking of the woody conducting tissue of the petiole; usually appearing as one or several dots.

Calyx. Collective term for the sepal of a flower, whether separate or fused.
Capsule. A dry, dehiscent fruit of a compound pistil.

Catkin. A scaly-bracted spike of usually unisexual flowers.
Caulescent. With a visible stem.
Chambered pith. Pith in transverse plates with air cavities between them.
Ciliate. Fringed with hairs on the margin.
Cinereous. Ashy gray.
Clasping. Said of the base of a leaf partly or wholly surrounding the stem.
Cm. Centimeter: about three-eighths of an inch (see scale on back cover).
Collateral buds. Accessory buds at the sides of the main axillary bud.
Compound. Composed of two or more separate parts, such as the leaflets of a leaf.
Connate. Union of like parts.
Cordate. Heart-shaped, or if of the base of a leaf, shaped like the lobed end of the conventional heart.
Corolla. Collective term for the petals of a flower, whether separate or fused.
Corymb. A flat-topped flower cluster with pedicels from a common axis, and the outer flowers opening first.
Crenate. Dentate with the teeth much rounded.
Crisped. Edges of the blade wavy in the plane perpendicular to its surface.
Cuneate. Wedge-shaped; narrower than acute.
Cuspidate. Tipped with a sharp and abrupt point, more prominent than mucronate.
Cyme. A flower cluster of successively forking stems, with central flowers opening first.

Deciduous. Dropping off in the autumn.
Decurrent. Extending down the stem below the point of origin.
Dehiscent. Capable of opening when dry.
Deltoid. Triangular.
Dentate. Toothed, the teeth pointing outward.
Divaricate. Widely divergent or spreading.
Doubly-serrate. Serrate with lesser teeth on the edges of the larger teeth.
Drupe. A fleshly fruit with its seed enclosed in a stony covering, forming a "pit"; or the pits may be several. Often resembling a berry.

Elliptic. With the outline of an ellipse, about 2 times as long as wide; broadest at the middle.
Entire. Margin smooth and even, without projections.
Exfoliating. Cleaving off in thin layers.

Falcate. The axis or midrib curved, suggestive of a scythe.
Fascicle. A close cluster.
Filiform. Thread-like and terete.
Floccose. With bunches of soft or woolly hair.
Floricane. Stem of a biennial plant in its second year, normally bearing flowers and fruit.
Fusiform. Spindle-shaped.

Glabrate. Nearly glabrous or becoming glabrous with age.
Glabrous. Without hairs.
Gland. A small surface protuberance, either secreting or not.
Glaucous. Covered with a whitish bloom.

Hastate. Shaped like an arrow-head but with the basal lobes spreading.
Head. A dense cluster of practically sessile flowers.
Herbaceous. Not woody.
Hirsute. With rather coarse or stiff hairs.
Hispid. With rigid hairs.
Hoary. Covered with a close grayish white pubescence.

Imbricate. Scales of the bud overlapping like shingles on a roof.
Incised. Sharply and deeply cut.
Indehiscent. Not opening.
Inflorescence. A grouping of flowers.

Internode. That portion of the stem between two nodes.

Lanceolate. Lance-shaped, several times as long as wide and broadest toward the base.
Leaf. The photosynthetic organ of a vascular plant, usually consisting of two parts, the petiole and the blade.
Leaf-scar. A scar left on the twig after the fall of the leaf.
Leaflet. One separate part of a compound leaf.
Legume. Dehiscent dry fruit of a simple pistil, normally splitting along two sides.
Lenticel. A small corky break or speck on young bark.
Linear. Long and narrow with parallel margins.
Lobed. Referring to a simple leaf which is divided into segments, deeply enough so that the segments, if bent over, will touch the midrib, or nearly so.
M. Meter: about 3 feet.
Membranous. Thin and rather soft.
Mm. Millimeter: one-tenth of a centimeter.
Mucronate. With an abrupt minute point.
Multiple fruit. Fruit formed by the coherence of pistils and associated parts of the several flowers of an inflorescence.

Node. The place on a stem which normally bears a leaf or leaves, and a bud or buds.
Nut. A hard, indehiscent, one-seeded fruit, usually from a compound pistil.
Nutlet. A small nut or a small stone of a drupe.

Oblanceolate. Inverted lanceolate, the broadest end toward the apex.
Oblique. Unequal-sided leaf, such that a line touching the base at both sides of the petiole would cross the petiole obliquely.
Oblong. Longer than broad, with the sides nearly parallel most of their length.
Obovate. Inverted ovate, the broader end toward the apex.
Obtuse. Blunt at the end; here used for between acute and rounded.
Opposite. Two at a node (of leaves, buds, or twigs).
Orbicular. Circular.
Oval. Broader than elliptic, about 1½ times as long as broad, and rounded at both ends; broadest at the middle.
Ovate. Comparable to the outline of a hen's egg, with the broad end toward the base.
Ovoid. An oval or ovate body.

Palmate. Parts radiating from one point or nearly so.
Panicle. A compound, elongated, irregularly branched grouping of flowers.
Pectinate. Comb-like; divided to narrow, close-set segments.
Pedicel. Stem of an individual flower of a flower cluster.
Peduncle. Stem of a solitary flower or the main stem of a flower cluster.
Peltate. Stalk attached to the under surface inside from the margin.
Perfoliate. The stem appearing to pass through the leaf.
Persistent. Remaining attached; usually referring to leaves which persist through the first winter.
Petiole. The stalk part of a leaf.
Petiolule. The stalk part of a leaflet.
Pilose. With soft long straight hairs.
Pinnate. Parts at intervals along both sides of an axis.
Plicate. In lengthwise plaits, as a fan is folded.
Pome. Fleshy fruit with bony, leathery, or papery several-compartmented core, and a soft outer part.
Prickle. A sharp outgrowth of the bark.
Primocane. Shoot from the base of a biennial plant in its first year, usually sterile.
Puberulent. Minutely pubescent.
Pubescent. Covered with hairs, especially if short and soft.
Punctate. With translucent or colored dots or depressions.

Raceme. A simple flower cluster of pedicelled flowers upon a common elongated axis, with lower flowers opening first.

Rachis. The axis of a compound leaf or of certain inflorescences.
Radiate. The structure of a composite inflorescence (head) having ray florets, simulating petals.
Radical. Pertaining to the root or originating from the root.
Reflexed. Abruptly turned backward or downward.
Reticulate. Netted, as when the network of veinlets is more than usually developed.
Retuse. With a shallow notch at a rounded apex.
Revolute. Margins rolled under toward the lower surface.
Rhizome. A horizontal underground stem.
Rugose. Wrinkled; generally due to the depression of the veins in the upper surface of the leaf.

Samara. An indehiscent winged fruit.
Scabrous. Rough to the touch.
Scurfy. Covered with small scales which are not flat and are easily scraped off.
Sepal. One of the usually green outer members of the flower.
Serrate. Sharply toothed, the teeth pointing forward, as in a saw.
Serrulate. Finely serrate.
Sessile. Without a stalk, as a leaf without a petiole.
Sheath. A tubular envelope, as the basal portion of a grass leaf.
Simple leaf. A leaf without wholly separate portions: not compound.
Sinuate. Margin strongly wavy, but not lobed.
Sinus. The concave recess between two lobes of a leaf.
Spatulate. Gradually narrowed downward from a rounded summit.
Spike. A flower cluster of sessile flowers upon an elongated axis.
Spine. A sharp, rather slender, rigid outgrowth.
Spinescent. Ending in a spine.
Spur. A short, rigid, slowly-grown branchlet, usually bearing a cluster of leaves at the end.
Stellate. Star-shaped; radiating or radiately-branched hairs.
Stipule. An appendage of the base of the petiole, usually one on each side.
Stipule-scar. A very slight scar sometimes present on each side of the upper edge of the leaf-scar, resulting from the fall of the stipule.
Stolon. A runner at the surface of the ground that takes root.
Striate. Marked with fine longitudinal lines or ridges.
Strigose. With appressed, straight, stiff hairs.
Subulate. Awl-shaped: rigid, tapering to a sharp point from a stouter base.
Suffrutescent. Slightly woody, or more so at base than above.
Superposed buds. One or more accessory buds above the axillary bud.

Tendril. A coiling thread-like organ by which a plant grasps support.
Terete. Circular in cross-section.
Thorn. A degenerated, sharp-pointed branch or twig.
Thyrsoid. Approaching a thryse, which is a compact narrow panicle.
Tomentose. Slightly hairy with the hairs tangled or matted.
Trifoliolate. A compound leaf of three leaflets.
Truncate. Ending abruptly as if cut off transversely.
Tuber. A thickened underground stem.
Tubercle. A small excrescence.
Twig. Here used for the shoot which has developed within the year, from the bud of the previous season.

Undulate. Margin wavy.

Valvate. Scales of the bud meeting by the edges and not overlapping.
Villous. With long, soft, usually curved or curly hairs.

Whorled. More than two at a node (of leaves, buds, or twigs).

Index

Antioch College,
Yellow Springs, Ohio.

The Genus Armeria in North America

George H. M. Lawrence

Introduction

This paper is the result of a taxonomic study of the genus Armeria as made originally from a world viewpoint. The plants are known commonly as thrifts. The writer (1940) first published a preliminary treatment in brief outline, that the units and the genus may be better understood in broad perspective. This earlier paper provided analytical keys, nomenclatorial changes, and an accounting of the synonymy of the multiplicity of names that had been applied legitimately to members of the genus. No detailed discussions, descriptions, citations of specimens examined, nor distributional studies were given. The present paper proposes to satisfy this deficiency insofar as the thrifts of North America are concerned.

In the study of material and preparation of notes for this and the preceding paper, over 4500 herbarium specimens were examined and annotated. In many instances, as noted below, the types were in European herbaria and, where these were not available on loan, photographs and/or diagnostic sketches of many of them were obtained. Except as noted (Lawrence, 1940 p. 394) this paper is based on an herbarium study and, aside from specimens seen growing along the coast of southern California, no living native plants have been studied in the field. Over 400 populations have been grown in the gardens at the Bailey Hortorium and detailed studies made of them.

History

A discussion of the generic status and nomenclature of the genus has already been given (Lawrence, 1940). Briefly, pre-Linnaean botanists, notably Tournefort, recognized the thrifts and the sea-lavenders as representing two genera, treating the former as *Statice* and the latter as *Limonium*. In his "Species Plantarum" Linnaeus (1753) combined them into a single genus, with the thrifts represented by a single species, *Statice Armeria* L. In 1768 Phillip Miller divided them, calling the thrifts *Statice* and the sea-lavenders *Limonium*. No further major changes in generic status occurred until 1809 when Willdenow, also recognizing them as constituting two genera, renamed the thrifts *Armeria* and retained for the sea-lavenders the Linnaean name of *Statice*. Here confusion began, and persists from this time to the present. Druce (1909) demonstrated that Miller's application of *Statice* for the thrifts had priority over Willdenow's name of *Armeria*. Most British and American botanists followed Druce, whereas the majority of Continental botanists adhered to Willdenow. To quote from my earlier paper (1940), "Despite this evidence [as presented by Druce] of the validity of the name *Statice*, and its unmistakable application by Miller to the thrifts, the present International Committee on Nomenclature has . . . conserved the names of *Armeria* for

the thrifts and *Limonium* for the sea-lavenders. The name *Statice* has been rejected as a *nomen ambiguum*."

The North American representatives of the genus have been subject to various interpretations. They are considered to be composed of six elements distributed as shown in Fig. 1. They were treated by early American authors as conspecific with Linnaeus' *Statice Armeria*. In 1831, Chamisso, working with material from Unalaska and Labrador, segregated one element and treated it as *A. vulgaris* Willd. f. *arctica* Cham. Wallroth (1844) published on the genus and raised Chamisso's plant (excluding Labradorian material) to *A. arctica*, and treated the material from Labrador as comprised of two additional species: *A. labradorica* Wallr. and *A. sanguinolenta* Wallr. Boissier (1848) in his monograph of the genus, treated the thrifts of much of the Pacific coast as var. *californica* of the South American *A. andina* Poeppig.

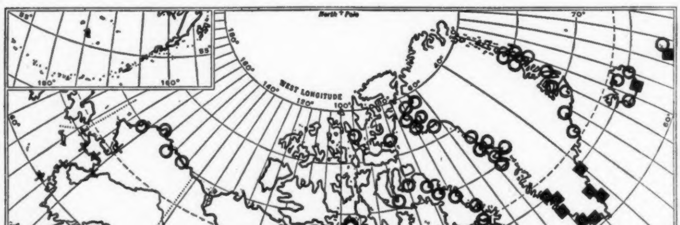


Fig. 1.—Distribution of North American populations of *Armeria:* crosses, var. *purpurea;* solid discs, var. *californica;* open discs, var. *sibirica;* solid squares, var. *typica;* solid triangles, var. *labradorica;* open triangle, one population at Hoosier Pass, Colo. (Cf. discussion under var. *labradorica.*)

Blake (1917) transferred the name to become *Statice arctica* var. *californica*. Rosenvinge (1892) treated the Greenland representatives in part as *A. vulgaris* Willd. var. *sibrica,* thus reducing Turczaninow's binomial (*A. sibirica*) to varietal status, and at the same time segregating a second Greenland population as *A. vulgaris* var. *maritima*. Raup (1936), by his collections from the Lake Athabaska region, materially extended the range of the genus and segregated the specimens as *Statice interior* Raup; these plants I have since treated as *A. maritima* var. *interior* (Raup) Lawr.

A study has been made of the papers concerning style- and pollen-dimorphism in Armeria, particularly those of Erdtman (1940), Iversen (1940), and Szafer (1945, 1946). No attempt was made by these authors to determine the extent of such dimorphism in all species, nor within all taxonomic variants of a given species of the genus. Studies of the condition as it concerns the family *Plumbaginaceae,* and more especially the species of the genera *Armeria* and *Limonium,* are being conducted cooperatively by Dr. J. G. Baker, of the University of Leeds, and myself. Only Iversen has applied these characters taxonomically to the American plants.

In his paper, Iversen expresses the opinion that the character of calyx vesture is not reliable for the establishment of Sections within the genus. In his search for such a character he concluded that pollen- and style-dimorphism was the only constant character and proceeded to employ it in the establishment of two sections for the genus, calling them *Dimorphae* and *Monomorphae*. Unfortunately the names are illegitimate, inasmuch as no Latin diagnosis is provided for either and no formal description is given for them. The Sections established by Boissier in 1848 are ignored without comment and the Subsections of the same monographer are abandoned as untenable. In the employment of his new "sections," Iversen conceded that he had not studied the pollen or style condition of the majority of species of the genus and accordingly placed in each section only those elements that he had studied. In this regard less than 5 percent of the species of Armeria were accounted for. By any standard, this seems a surprisingly small ratio on which to derive evidence for the establishment of generic sections.

On the basis of evidence presented by the three authors cited, and on that obtained independently, it is clear that style- as well as pollen-dimorphism has arisen independently within the family. It is known to exist in some, but probably not in a majority of species, of three genera of the family. It is not known whether the pollen of a majority of these genera is dimorphic or monomorphic. In the absence of this information, it seems somewhat presumptive to base sections of any of these genera on this character. Furthermore, in the analysis and evaluation of the two generic "sections" proposed by Iversen, as substitutes for the existing sections of Boissier and Wallroth, consideration must be given to the fact that the determination of the style or pollen type required to place a plant of the genus in the Iversen "sections" must be made with the aid of a microscope that will magnify to 40 diameters or more, this a condition not required in the identification of representatives of *Macrocentron* Boiss. or *Plagiobasis* Boiss.; there are no distributional areas representative of

Monomorphae and *Dimorphae,* whereas they do exist for the Boissier sections; and in at least one other instance (*Primula vulgaris*) the character of style dimorphy occurs within single populations of the one species. In view of the fact that Iversen does not mention Boissier's sections of Armeria, but by inference treats and rejects the subsections *Pleurotrichae* Boiss. and *Holotrichae* Boiss. (of § *Plagiobasis* Boiss.) it may be that he actually intended his so-called "sections" to serve as subsections of the Sect. *Plagiobasis* Boiss.

Unfortunately there is little accord between the paper by Iversen and that of the present paper with regard to the taxonomic treatment of the American thrifts, or the nomenclature employed for them.

Iversen placed the only dimorphic entities that he encountered in his section *Dimorphae*. In the treatment of this element as *A. vulgaris* Willd. no mention was made of Philip Miller's name *Statice maritima,* a binary name having nearly a half-century of priority over *vulgaris*.

Section *Monomorphae* contains three species: *A. macloviana* Cham., *A. chilensis* Boiss., and *A. scabra* Willd. Iversen placed "comb. nov." after the authority given for each of the first two binomials. However, no new binomial combinations were involved. The North American populations of Armeria were treated as representing three subspecies of two species: *A. macloviana* ssp. *californica* (Boiss.) Ivers., for the plant treated in the present paper as *A. maritima* var. *californica; A. scabra* ssp. *arctica* (Cham.) Ivers. for the populations here treated as *A. maritima* var. *purpurea;* and *A. scabra* ssp. *labradorica* for those elements treated as *A. maritima* var. *sibirica* and var. *labradorica*. The characters provided by Iversen for *A. scabra* ssp. *arctica* and *A. macloviana* ssp. *californica* respectively are inadequate for separating the abundance of material that has been available to me, and there is no indication in his discussion of these elements that he was cognizant of the blending of these populations in the Puget Sound area. It is of interest to note that the only reliable character provided by him for the separation of the north temperate and circumboreal *A. scabra* from the south temperate and Chilean *A. chilensis* is that of their great geographical discontinuity—if such may be considered a taxonomic character *per se*. Supplemental characters given by Iversen for the separation of these elements are not reliable (collectively or singly) if applied to the material that has been available to me. In his nomenclatorial treatment of the South American *A. chilensis* Boiss., Iversen ignored Bertoloni's legitimately published name, *A. curvifolia,* a binomial that antedates Boissier's name by eighteen years. Few authors dealing with the plants since Boissier have considered them as representing separate species. It appears also that Iversen was unable to see morphological differences between the vars. *labradorica* and *sibirica* of the present paper, since he treated the two as conspecific under his ssp. *labradorica*. From his citation of specimens examined, it is apparent that he had access to specimens from northeast Greenland and from Siberia not available to me during the course of the present study.

Despite the divergences of taxonomic and nomenclatorial opinions as presented in these two papers, great respect is held for Professor Iversen's ecological interpretations and attendant field knowledge of the Danish and Scandi-

navian thrifts. His understanding of them and the apparent thoroughness with which he has conducted considerable experimental taxonomic research, especially with regard to the many transplants of dimorphic and monomorphic types under varying ecological and edaphic conditions, have made possible a contribution filled with many valuable data and sound information. It appears to the writer that perhaps an undue enthusiasm may have been partially responsible for Iversen's placing such taxonomic importance on the character of pollen and style dimorphism. The employment of it in establishing generic sections or of necessity in separating populations as separate species, is not acceptable at this time.

Economic Importance

Of the thirty-five species recognized by the writer as comprising the genus, fourteen are known to be cultivated in this country and grown for ornamental purposes. None of the American thrifts is known to be cultivated, except those of the Puget Sound area which have been advertised by northwestern dealers of native plants. The Old World species have been grown in gardens since the sixteenth century, early for medicinal purposes and later only for ornament.

Taxonomic and Morphological Considerations

Any taxonomic treatment of the North American thrifts must take into account their relationships to the circumboreal thrifts of the Old World since it is as if the thrifts formed an irregular and disjunctive zonal band in the floristic regions adjoining the Arctic circle, with fingers of extension projecting down the Scandinavian peninsula south along the Baltic Sea to the coast of Normandy, north of the Pripet Marshes of Poland, mountains of Transbaikalia and the Lake Baikal region of Siberia, northern Manchuria, the Chukch peninsula to Kamtchatka and the Saghalin Islands of Japan. Crossing over into North America they extend down its west coast to San Diego, California, the Hudson Bay areas, the east coast of North America from King William Land into Quebec, the coasts of Greenland and again in the Old World in Iceland, the Faroes and British Isles. There are several greatly isolated stations between these centers of extension in both hemispheres. It is believed that these elements represent a single polymorphic species, *A. maritima* (Mill.) Willd.; that a single element of that species, var. *sibirica* (Turcz.) Lawr. is essentially circumboreal, and that the plants of the southerly projecting ranges represent evolutionary developments of it. Accordingly, and for additional reasons given later, the American representatives of the genus are here treated as varieties of *A. maritima* (Mill.) Willd.

Numerous authors, Rosenvinge (1892), Simmons (1906), Ostenfeld (1910), Hultén (1937) et al., have likewise considered the American populations treated by them as subspecific entities of one or another Old World species. However, except for Simmons, they did not take up the binary *maritima* for the binomial. I have been unable to treat *A. vulgaris* Willd. as specifically distinct from *A. maritima*,[4] and the latter being the older epithet has priority over the more currently employed name of *A. vulgaris*.

The genus does not afford an abundance of sharply differentiated morphological characters. Following Boissier (1848), previous authors and students of the group have endeavored to distinguish subsections and species on the basis of the nature and extent of calyx vesture. The funnel-form, semiscarious, calyx of the thrift is characterized by having five primary and five secondary ribs, each of the latter joined apically to the former by a connecting rib (cf. Lawrence, 1940, Fig. 250). Boissier placed the American thrifts in each of two subsections, depending on whether the ribs plus their intercostal spaces were wholly pilose, or whether only the ribs were pilose and their intercostal spaces glabrous. He considered those plants having calyces fitting the first situation as *holotrichous* and those of the second, *pleurotrichous*.

The reliability of the vesture of the calyx-tube has been the subject of much discussion. Among those who have opposed Boissier and Wallroth concerning the value of the calyx-tube vesture as a cardinal taxonomic character, may be mentioned Sir Joseph D. Hooker (1847), C. C. Babington (1849), Grenier and Godron (1852), Boswell Syme (1867) and Willkomm and Lange (1870). This dissension or open opposition consisted only of nonusage of Boissier's characters or mere statements of opinion, and was not supported by material evidence. On the contrary Druce (1901) presented data in support of the validity of the characters. Herbarium specimens supporting his contentions were cited.

Investigation of the reliability of calyx-tube vesture has resulted in my conclusion that, while it may be reliable in the separation of some of the more stable species, it is very variable in the more polymorphic units and is not worthy of consideration as a sectional or subsectional character.

Armeria maritima var. *typica* of this paper has been the subject of most of the earlier discussions relative to calyx-tube pubescence. It is the entity discussed by Druce and for that reason was selected for study resulting in evidence believed to refute Druce's contentions.

Druce contended that there was no actual intergradation between calyces having only pubescent vertical ribs and those having the combination of pubescent vertical ribs and pubescent intercostal spaces. Blake (1917), while defending the validity of the subsection *Holotrichae* Boiss. for the northeastern Canadian plants, admitted essentially that the specimens assigned to this subsection might have glabrous intercostal spaces, for he stated (p. 3) ". . . the calyx-tube is more or less hairy between the ribs, at least in the neighborhood of the oblique rib connecting the intermediate ribs at the apex with the main ribs of the calyx, which itself (i.e. the cross-rib) is also hairy. . ." In other words, according to Blake, specimens hairy on the vertical ribs and on the connecting ribs would belong to the *Holotrichae* even though the intercostal spaces be glabrous. This is not in accord with Boissier's diagnosis of the *Holotrichae*.

One of the supporting arguments for Druce's contentions was that he considered the character of the calyx-tube vesture to be reliable because he

had been unable to find two fruiting calyces from the same plant that differed with regard to the degree of pubescence. I have examined critically four to six calyces from each of two hundred and sixteen collections of *A. maritima typica* and among them have found that the heads of plants of seven collections contained both pleurotrichous and holotrichous calyces. These collections are cited below.[1]

While I do not place confidence in calyx-tube vesture as a sectional or subsectional character, it does appear to be of value when dealing with polymorphic species as a secondary character in the delimitation of less than specific entities. There are several endemic species of restricted distribution whose calyces are consistently pleurotrichous, but there appear to be none whose calyces are holotrichous without exception.

In only one population of American thrifts are the calyces known to be wholly glabrous. It is represented by specimens collected by Raup and treated here as *A. maritima* var. *interior*.

As a result of studies of extensive herbarium material, more confidence has been placed in the shape and relative size of the involucral bracts, general aspect of the plant, morphology of the calyx and degree of development of its component parts, and size ratios of sheaths to heads, rather than on vesture of calyces or of foliage. Evidence militating against placing great confidence in the calyx vesture is considered equally applicable to Old World populations of the *A. maritima* complex.

Materials Studied

For this study, material in the following herbaria[2] has been examined. The material from institutions marked below with an asterisk has been seen as of 1938, while that from the others has been seen as of February 1946. To the curators of all of these collections I express my gratitude.

BH—Bailey Hortorium, Cornell University, Ithaca, N. Y.
*BR—Jardin Botanique de l'Etat, Brussels, Belgium
*C—Universitetets Botaniske Museum, Copenhagen, Denmark
*CAN—National Herbarium of Canada, Ottawa, Ont.
CAS—California Academy of Sciences, San Francisco, Calif.
CU—Department of Botany, Cornell University, Ithaca, N. Y.
DS—Dudley Herbarium, Stanford University, Palo Alto, Calif.
*F—Chicago (Field) Natural History Museum, Chicago, Ill.
*GH—Gray Herbarium, Harvard University, Cambridge, Mass.
*L—Rikjs Herbarium, Leiden, Netherlands
LA—University of California at Los Angeles, Los Angeles, Calif.
*MO—Missouri Botanical Gardens, St. Louis, Mo.

---

1 Specimens of *A. maritima* var. *typica* having pleurotrichous and holotrichous calyces within the same head: SWEDEN: Larson, P., July 1866 (NY). GERMANY: Keller, W. C. C., (PH, no. 521667). BRITISH ISLES: Barton, W. C., Cardijan, Wales, Sept. 1923 (F). FRANCE: Clermont, T. de, no. 236 in part, (BH); Eloy de Vica, L., no. 127 (BH); Frolich, S. (L, no. 910-143-298).

2 Abbreviations employed are those recommended by Lanjouw, J., in Chronica Botanica **5**:142-150, 1939.

MT—Institut de Botanique, Universite de Montreal, Montreal, Que.
*NY—New York Botanical Gardens, New York, N. Y.
*O—Universitetets Botaniske Museum, Oslo, Norway
OTB—Division of Botany, Central Experimental Farm, Ottawa, Ont.
OSC—Oregon State College, Corvallis, Ore.
*PH—The Academy of Natural Sciences, Philadelphia, Pa.
*UC—University of California, Berkeley, Calif.
*US—United States National Herbarium, Washington, D. C.
WILLU—Willamette University, Salem, Ore.
WTC—Washington State College, Pullman, Wash.
WTU—University of Washington, Seattle, Wash.

ARMERIA Willd., Enum. Pl. Hort. Berol. 1:333, 1809.

Statice L., Gen. Pl. n. 388, *pro parte; Statice* L. emend. Mill., Gard. Dict., ed. 8, 1768.

Perennial herbaceous or suffrutescent plants of low tufted, cespitose habit; *stem* short, little to much branched, short internodes, compact; each branch terminated by a leafy rosette and usually subtended by the remains of decurrent leaf bases: *leaves* linear to lanceolate or oblanceolate, alternate with high phyllotaxy, sessile or often amplexicaulous, one to seven nearly parallel nerves, obtuse to acute, margin glabrous to ciliate and entire to minutely undulate: *scape* usually terete, glabrous to densely pubescent, occasionally prominently glandular-pustular, simple, leafless, monocephalic: *head* spherical to hemispherical, subtended by two or more rows of sterile bracts forming an involucre of which the two outermost bracts have become divergently reflexed and by marginal connation form a tube-like *sheath* about the scape: *inflorescence* a head comprised of a number of much-condensed cymules or spiculae; *spicula* sessile or stipitate and arising from the axil of a somewhat herbaceous fruiting bract (vestigial or absent in some species), each spicula consisting of two to seven pedicellate flowers, the subtending bracts of the latter may or may not be fully developed: *flowers* perfect, shortly pedicellate: *calyx* gamosepalous, infundibular, comprised of 5 sepals, marginally connate, 5-lobed, 10-ribbed, mid-vein of each primary lobe usually excurrent and forming a distinct *cusp;* calyx-tube scariously herbaceous, glabrous to pubescent; calyx-limb membranous, often somewhat plicate; the calyx-lobes obovate to oblong, entire, white to rosulane-purple; *stamens* 5, filaments slightly spreading at base, adnate to petals: *styles* 5, slightly connate at base, tomentose-pubescent along basal third, narrowly filiform, divergent, without conspicuous stigmatic area: *ovary* somewhat obconical, slightly adnate laterally to calyx, apex gibbous and remotely 5-lobed: *ovule* solitary, anatropous: *fruit* a one-seeded utricle: *seed* albuminous, dicotyledonous.

In the past the genus has been considered as typified by Linnaeus' specimen determined by him as *Statice Armeria.* Prof. B. D. Jackson (1912) cited this specimen as having been in the Linnaean Herbarium as of 1753 and as having its label in Linnaeus' handwriting. A photograph of the specimen has been studied by me and is in the Bailey Hortorium herbarium. It has been determined—subject to subsequent examination of the specimen itself—as *A. maritima* var. *elongata*. Because it clearly is not the entity Miller had when describing *Statice maritima* (the next oldest valid binomial), Linnaeus' speci-

men *per se* is considered to have no standing as a type for either the genus or a currently accepted binomial. In the list of lectotypes proposed by M. L. Green in Briquet et al. (1935), the name *Armeria vulgaris* Willd. is given. Photographs, diagnostic sketches, and a fruiting calyx of the Willdenowian specimen of *A. vulgaris* were provided me by Prof. Robert Pilger, Berlin-Dahlem, in 1937. As a result of study of these, the Willdenow specimen was subsequently treated as *A. maritima* var. *purpurea* (Mert. & Koch) Lawr., the epithet *purpurea* being the oldest in the category of *varietas*. It is believed that the lectotypic species of the genus should be *Armeria maritima* (Mill.) Willd.

Attention is invited to the fact that Willdenow did not cite Miller's earlier name of *Statice maritima* in synonymy under his *Armeria maritima*. Nonetheless, Miller's name is the oldest validly published bionmial for the species. In accordance with Art. 54 of the International Rules, ". . . When the specific epithet, on transference to another generic name, has been applied erroneously in its new position to a different plant, the combination must be retained for the plant on which the epithet was originally based." The epithet *maritima* was based originally on Phillip Miller's plant. By this rule, if it is established that Willdenow's name is not based on Miller's plant, then Willdenow cannot be accepted as the author of the combination *A. maritima* (Mill.) Willd. It would appear, on casual study, that such was the situation, for Willdenow (1809) makes no mention of Miller's name or of the names of other species of the genus named (under *Statice*) by Miller. There is no question in my mind but that Miller's plant and that of Willdenow, although not based on the same specimen *per se,* are the same entity and that the var. *typica* of this treatment embraces both plants.

In the list of examples following Art. 54 (quoted above, in part) is given:

> *Chailletia hispida* Oliv. (Fl. Trop. Afr. I, 343: 1868) when placed under the generic name Dichapetalum (an older name for the same genus), must be called *Dichapetalum hispidum* (Oliv.) Baill. (Hist. Pl. V, 140: 1874).

Investigation reveals that Baillon, in his general discussion of the Dichapetalum Series of Euphorbiaceae, referred to two African species, one of which he treated as *Dichapetalum hispidum* without any author citation. In a footnote on the same page he made reference, among others, to Oliver's treatment in Fl. Trop. Afr. Baillon knew Oliver's work, but he did not give the name *Chailletia hispida* as a synonym of *D. hispidum:* there is nothing to indicate that the latter is based on the former. As regards the situation under discussion in *Armeria,* Willdenow likewise did not cite Miller's name. Unlike Baillon, he did not mention the source of publication of an earlier name by Miller. However, we do know that Willdenow, prior to the time of publication of his *A. maritima,* did know of Miller's work and of his herbarium, for both are mentioned in Willdenow's preface to Linnaeus' Species Plantarum (1797), ed. 4 (pp. xiii and xxvi).

For this reason it is considered that Willdenow did know of Miller's earlier name of *Statice maritima* even though he did not cite it. In view of the

fact that Baillon did not deliberately nor specifically base his name of *Dichapetalum hispidum* (a name presented as an acceptable example of the application of Art. 54 of the International Rules) on *Chailletia hispida* Oliv., it would appear that it is equally correct to take up the name of *Armeria maritima* (Mill.) Willd. as the proper binomial and author citation for the species in question, even though types of the two names may not be identical. In the apparent non-existence of Miller's specimen, that of Willdenow is considered to be the type.

KEY TO THE AMERICAN VARIETIES OF A. MARITIMA (MILL.) WILLD.

1. Outer involucral bracts usually one-half as long as inner oes or less; inner involucral bracts obtuse: leaves flat, rarely exceeding 6 cm. in length............2. var. *sibirica*
1. Outer involucral bracts more than one-half as long as inner ones: leaves flat, recurved or slightly contorted and canaliculate, usually 3-18 cm. long.
   2. Calyx-tube glabrous: leaves 5 cm. long or less, usually 2.0-3.5 mm. wide............4. var. *interior*
   2. Calyx-tube vestured, at least on the vertical ribs: leaves usually more than 5 cm. long, but if shorter then 1.8 mm. wide or less.
      3. Inner involucral bracts obtuse; calyces with connecting ribs pubescent and the intercostal spaces usually so; scapes rarely exceeding 18 cm. in length, erect; sheath shorter than width of head ....3. var. *labradorica*
      3. Inner involucral bracts acute, mucronate or obtuse; calyces with intercostal spaces glabrous or pubescent but if pubescent then the inner involucral bracts are usually mucronate and rarely strictly obtuse; scapes often more than 20 cm. long; sheath usually longer than width of head.
         4. Outer involucral bracts usually mucronate; inner bracts mucronate to mucronulate and occasionally obtuse (when obtuse the outer ones are mucronulate), longer than the outer ones: leaves usually 1.0 mm. wide or less; calyces with intercostal spaces glabrous or pubescent ....1. var. *typica*
         4. Outer involucral bracts obtuse, acute or cuspidate; inner ones acute or obtuse: leaves usually 1.5 mm. wide or more: calyces with intercostal spaces glabrous.
            5. Bracts of outer involucre triangular to attenuately lanceolate in outline, equalling or exceeding the head or at least longer than the inner involucral bracts: leaves glabrous ....6. var. *californica*
            5. Bracts of outer involucre ovate to obovate, obtuse, usually shorter than the inner involucral bracts: leaves often minutely ciliate, at least along basal half ....5. var. *purpurea*

1. A. MARITIMA (Mill.) Willd. var. TYPICA.[3]

Statice maritima Mill. Gard. Dict., ed. 8, n. 3, (1768).
Armeria maritima Willd. Enum. Plant. Hort. Berol. **1**:333, (1809).
A. vulgaris Wild. var. *maritima* (Mill.) Rosenv. in Meddel om Grønl. **3**:683, (1891).
A. elongata (Hoffm.) Koch var. *maritima* (Mill.) Skottsb. in Kungl. Svensk. Vetens. Akad. Handl. **56**:285, (1916).

Plant cespitose, of multicipital rosettes: *leaves* all similar, narrowly linear,

---

3 For more complete synonymy of this and following entities, cf. Lawrence (1940) pp. 403-406.

3-10 cm. long, to 1.5 mm. wide, flat, slightly contorted or basally canaliculate, usually obtuse, glabrous or ciliate, dorsal sides occasionally villous along midrib or longitudinal veins, primary vein 1: *scape* 6-20 cm. tall, as wide as leaves or wider, glabrous to densely tomentose: *sheath* slightly longer than head is wide: *head* subglobose, to 2 cm. across: *outer involucral bracts* mucronate, the mucro originating from the elongation and projection of the midrib and may pass through or over the apical scarious margin, usually extends 0.2-0.8 mm. beyond point of emergence: *spiculae* sessile: *interfloral bracts* present, as long as calyx; *pedicel* usually as long as calyx-tube but shorter in non-fruiting calyces: *calyx-tube* pubescent on vertical ribs, usually pubescent on connecting ribs, but often glabrous on intercostal spaces although in many instances the entire tube is so densely pilose to strigosely-tomentose as to obscure the identity of the ribs and connecting ribs, and infrequently different calyces within a single head may show varying degrees and extent of vesture; *calyx-lobes* emarginate, truncate, obtuse to triangular, 0.2-1.4 mm. long, the *cusp* 0.1-0.5 mm. long and occasionally absent; *calyx-spur* absent, the calyx base usually obtuse.

The characters to be employed in the determination of the typical element of *A. maritima* long have been a source of controversy. The plant may be identified and separated from its near relatives of the same species complex, not by the presence or absence of any single character, but rather by a group of characters collectively. Those set forth in the key above have served in this regard.

Several geographic races of Old World populations of this entity can be discerned, characterized by pubescence differences not associated with other characters. The representatives as occurring in North Amrica are limited to southern Greenland, and are reasonably constant among themselves but blend directly into the more northern var. *sibirica* and in many cases they grow together in the same stations.

SOUTH GREENLAND: *Boegvad, R.*, no. 1308 (C); *Eberlin, P. Q.*, Aug. 1885 (C); *Hartz, N.*, Aug. 1889 (C); *Lundholm, U.*, 1889 (C); *Petersen, C.*, July 1880 (C); *Porsild, A. E. & M. P.*, Aug. 4, 1925 (C, CAL, US); ibid., Aug. 5, 1925 (C, CAN, NY, US); *Rosenvinge, L. K.*, July 17, and July 22, 1888 (C).

2. A. MARITIMA (Mill.) Willd. var. SIBIRICA (Turcz.) Lawr. in Gentes Herbarum **4**:405, 1940.

Armeria sibirica Turcz. ex Boiss. in DC. Prod. **12**:578, (1848). Based on a specimen collected by Turczaninow in the Lake Baical region of southeastern Siberia, believed to be in Herb. Boissier, Geneva.

Statice sibirica (Turcz.) Ledebour, Fl. Rossica **3**:456, (1853).

A. vulgaris Willd. var. *sibirica* (Turcz.) Rosenv. in Meddel om Grønl. **3**:683, (1892).

S. maritima Mill. var. *sibirica* (Turcz.) Simmons in Report of Second Norw. Exped. Fram, p. 34 (1906).

S. Armeria L. var. *sibirica* (Turcz.) Ostenf. & Lund. in Meddel om Grønl. **43**:30, (1910).

Differs from typical element in *leaves* 2-6 cm. long and to 2.5 mm. wide,

flat, somewhat fleshy in texture, apices often reddish, acute or rarely obtuse: *scape* 2-14 cm. long, rarely to 18 cm.,[4] glabrous or infrequently pubescent: sheath 1.4-2.0 cm. long: *head* 1.2-1.8 cm. across: *outer involucral bracts* one-half as long as inner ones or less, triangular-acute or obtusely so, not scarious or only narrowly so, glabrous, often suffused with pink or mallor-red: *inner involucral bracts* obtuse, broadly scarious with margin often erose, frequently colored apically as in outer ones: *calyx-tube* pubescent on vertical ribs, pubescent or glabrous on connecting ribs and on intercostal spaces; the *calyx-lobes* triangular with *cusp* 0.2-0.4 mm. long; the *calyx-spur* absent, but base of calyx usually narrowed and attenuate, extending 0.1-0.4 mm. below the narrowly obtuse foveola.

The variety *sibirica* represents a geographic race but, as pointed out by Simmons (1906), it and typical *A. maritima* "are connected by a continual series of intermediate forms" and that "in its most northern localities *S. maritima* seems always to be represented by var. *sibirica*." This situation is encountered at the southern distributional limits of the entity from Alaska across to Baffin Land and Greenland. As shown by Fig. 1, it blends into any of the other three nomenclatorially recognized variants (typical *A. maritima*, var. *labradorica*, and var. *purpurea*) with no stations yet discovered connecting it with var. *interior*.

Simmons also inferred (l. c.), as Malte (1934) has indicated, that the plants of Arctic North America all belong under his *Statice maritima* var. *sibirica*. Malte would distinguish the arctic var. *sibirica* from var. *labradorica* on the basis of leaf apex: obtuse in the former and acute in the latter. Such a distinction does not seem to be reliable, for although Turczaninow described his plant as having the leaf apex obtuse, I have found a significant number of specimens ascribable to none other than this entity from Europe and North America, having leaf apices acute while specimens from Asia did have obtuse apices. The aspect of the arctic var. *sibirica* contrasts with that of var. *labradorica*, for the leaves of the former are typically shorter, often wider, distinctly more fleshy, and tinged reddish at the apex. The coloration of the involucral bracts is usually reliable when present, but some collections of var. *labradorica* from the vicinity of Hudson Strait and of var. *typica* from the Faroe Islands have had similarly colored involucres and leaf tips. This coloration may well be a response to climatic or edaphic factors.[5] Individuals of this variant and of var. *purpurea* from Alaska occasionally indicate a blending of involucral bract characters, and the calyces may not be conspicuously different. However, in all confusing cases it was noted that the leaves of plants determined to be var. *purpurea* were ciliate at least along the basal half and were narrower in proportion to their length. At its southern limits of distribution the distinguishing

4 Böcher (1938) reports a specimen from Ivgtut, Greenland, having scapes 35 cm. long and heads 26 mm. across and suggests it may represent a polyploid form.

5 Transplants made by Turesson (1930) from high altitudes of the Faroes and from Norway showed no change in character after a year's cultivation at sea-level. F_1 progeny retained parental characters of height of scape, corolla color and relative time of flowering.

characters of var. *sibirica* break down, and it does intergrade with adjoining elements.

The var. *sibirica* is a plant of various habitats. In Greenland it was observed by Gelting (1934, p. 152) to be most abundant in bare gravel along beaches and sometimes in heaths, usually in solitary but multicipital tufts. Similar observations were made by Böcher (1938) who also showed in addition that the plants of this variant had not been collected north of 82° Lat. and very rarely south of 70° Lat. In Iceland it is reported to be more pulvinate in habit. Solonevicz and Korczagine (1934) describe it as growing on the tundra along northern wastes of Siberia and in alpine meadows in the Ural Mts. I have studied collections from Manchuria and northern Russia. Material has been examined from the higher elevations of the Faroe Islands and in southernmost Ellesmereland it has been collected by Simmons at a point approximately 600 miles north of the Arctic Circle.

Polunin (1940), following Blake, includes all of the material of Greenland and the Arctic Archipelago in his concept of *A. labradorica* without admitting the circumboreal distribution of var. *sibirica* or discussion of the relationships between the two entities. Polunin further notes that he found no confirmation of Ostenfeld's claim that var. *sibirica* occurs in East Greenland between 81° and 83° Lat. I have seen no specimens collected north of 77° Lat. in East Greenland.

ALASKA: (Point Hope to Izembek Bay region) *Ames, F.*, no. 82 (F); *Murie, O. J.*, June 1925 (GH); *Rasmussen, K.*, no. 1324 (C). KING WILLIAM LAND: *Hansen*, July 1904 (C); *Lindstrom, A. H.*, July 1904 (NY); *Rasmussen, K.*, no. 1174 (C). HUDSON BAY region: *Bauysted, H.*, no. 1079 (C); *Birket-Smith, K.*, nos. 623, 624, & 1046 (C); *Freuchen, P.*, no. 664 (C, CAN); *Johansen, F.*, nos. 98849 (C, CAN, GH, NY, US), 98850 (CAN); *Macoun, J. M.*, no. 79392 (C); *Malte, M. O.*, nos. 120459 in part (GH), 120528 in part (CAN, GH); *Parry* in 1821 (C). NORTH DEVON ISLAND: *Malte, M. O.*, nos. 119107 (C, GH, US), 119109 (CAN, GH). ELLESMERELAND: *Simmons, H. G.*, no. 1625 (C, NY). BAFFIN LAND: *Freuchen, P.*, no. 891 (C); *Kumlein, L.*, no. 1053 (NY); *Malte, M. O.*, nos. 119110 (CAN, GH), 120354 (C, CAN GH); *Palmer, S. C.*, Aug. 1912 (PH); *Robinson, R.*, nos. 19, 65 (GH); *Sewall, C. S.*, no. 324 (MO); *Soper, J. D.*, no. 111661 (C). GREENLAND (West Greenland) (Adam Biering's Land south to Disco Island); *Bartlett, R.*, nos. 71 (NY), 101 (GH, US); *Ekblaw, W. E.*, nos. 610 (F, GH, US), 611, 613 (GH), 614 (CAS, GH); *Freuchen, P.*, July 1914 & Aug. 1917 (C); *Hagerup, O.*, July 1925 (PH); *Hartz, N.*, July 1890, Aug. 1890 (C); *Koch, L.*, July 1916 (C); *Koelz, W.*, nos. 70 & 227 (US); *Lindholm*, May-June 1890 (C, MO); *Lylow*, July 1883 (GH); *Nygaard, J. N.*, July 1921 (C, CAN, GH, NY); *Olsen, G.*, 1917 (C); *Porsild, M. P.*, Aug. 1911 (C); *Stein, R.*, nos. 11, 175 (US); *Vanhoffen, E.*, no. 54 (C); *Wetherill, H. E.*, nos. 65 (GH, PH), 122 (GH), 143 (GH, PH), 176 (GH); *White, D. & Schuchert*, no. 176 (US). (Disco Island and adjoining Disco Bay region): *Burk, W. H.*, no. 47 (MO, NY, PH, US), *Engwell, M. E.*, no. 28 (C); *Fries, T. M.*, June 1871 (C); *Hansen, S.*, July 1888 (C); *Krumlein, L.*, no. 1546 (NY); *Moller*, 1845 (C); *Pedersen, M.*, no. 1909 (C), July 1898 (US); *Porsild, M. P.*, nos. 274, 380 (C), 393 (GH), Sept. 13, 1938 (CAS). (Disco Bay region south to Holstenborg): *Deichman*, June 1909 (C); *Sewall, C. S. & A. C. Week*, July 1926, Aug. 1926 (F); *Warming, E. & T. Holm*, July 12, July 13, 1884 (C). (Northeast Greenland) (Denmarks Havn south to Scorsby Sound): *Bartlett, R.*, no. 62 (NY); *Kruse, C.*, nos. 214, 517 (C); *Lundager, A.*, Aug. 1907 (NY), no. 1146 (C, CAN, US); *Oosting, H. J.*, nos. 576, 651, 717, 741, 951, 1015, 1156 (CAS); *Seidenfaden, C.*,

nos. 39 (NY), 98, 165 (C, NY), 303 (DS), 378, 409 (C, NY), 663 (C), 742 (US), 817 (NY), 924, 988 (C). (Scorsby Sound south to Angmagssalik): *Bay, E.*, Sept. 1892 (C); *Bogvad*, no. 1220 (C); *Freuchen, P.*, June 1908 (C); *Hagering, O.*, Sept. 1924 (C); *Hartz, N.*, Aug. 1900 (C); *Kruse, C.*, Aug. 1900 (C); *Lundager, A.*, no. 1676 (C); *Menzies, R. H.*, no. 16 (CAS); *Pedersen, A.*, June 1925 (C, CAN), July 1928 (C), July 1929 (C, GH); *Ryder, C.*, Aug. 1891 (GH, US); *Torgvessen, M.*, no. 645 (C).

3. A. MARITIMA (Mill.) Willd. var. LABRADORICA (Wallr.) Lawr. in Gentes Herbarum **4**:405, 1940.

Statice Armeria L., pro parte, sensu Amer. Auth., Sp. Pl. ed. 1, p. 274, 1753.

Armeria labradorica Wallr., Beiträge, Heft 2, p. 185, (1844). Wallroth states that the material on which he established the species was collected in the swamps of Labrador in the summer of 1833. Among his collections, borrowed from Prague, was found only one sheet containing (along with material of other species) only individual calyces and involucral bracts that had been dissected from the head and pasted on the sheet. No data as to source or dates of collection were given. The material is too inadequate to be considered the type of this variety. No type is designated at this time inasmuch as it seems advisable to determine if other collections known by Wallroth yet exist in other European herbaria.

A. vulgaris Willd. III *maritima* (Willd.) Petri (c) *labradorica* (Wallr.) Petri, Gen. Arm. p. 41, 1863.

S. labradorica (Wallr.) Hubbard & Blake in Rhod. **19**:6, (1917).

S. labradorica (Wallr.) Hubb. & Blake var. *genuina*, l. c. A variant having long-cuspidate calyx-lobes and ascribed to plants of Greenland and Labrador. Intermediate forms between this and var. *submutica* are not uncommon.

S. labradorica (Wallr.) Hubb. & Blake var. *submutica* Blake, l. c. A variant with mucronate calyx-lobe cusps, indicated by Blake to occur throughout the range of *S. labradorica* Hubb. & Blake, thus representing a weak *varietas* according to the Fernaldian concept of the category and as followed by Blake.

S. labradorica var. *submutica* f. *glabriscapa Blake*, op. cit. p. 7.

S. labradorica var. *submutica* f. *pubiscapa* Blake, l. c.

A. labradorica Wallr. var. *submutica* (Blake) Lewis in Can. Field-Nat. **46**:40, 92, (1932).

A. labradorica Wallr. var. *submutica* (Blake) Lewis f. *glabriscapa* (Blake) Lewis, l. c.

A. labradorica Wallr. var. *submutica* (Blake) Lewis f. *pubiscapa* (Blake) Malte in Rhod. **36**:185, (1934).

A. labradorica Wallr. var. *genuina* (Blake) Malte, l. c.

A. scabra Willd. ssp. *labradorica* (Wallr.) Iversen in Danske Vidensk Selskab., Biol. Meddel. **15**: no. 8, p. 18, (1940).

The Labradorian plant differs from typical *A. maritima* in the *leaves* acute or less commonly obtuse, 3-10 cm. long and to 1.8 mm. wide, flat, margins glabrous or infrequently ciliate along basal third: *scape* 3-20 cm. long, rarely to 32 cm. long, glabrous to densely pubescent: *sheath* shorter than head is wide: *head* rarely exceeding 2.0 cm. across: *outer involucral bracts* acute or obtuse, rarely mucronate, narrowly scarious: *inner involucral bracts* usually obtuse, broadly scarious, usually pale tan-colored: *pedicel* usually shorter than the calyx-tube, but occasionally as long as that of the first flower of the spicula: *calyx-tube* pubescent on the vertical and connecitng ribs, usually so on the

intercostal spaces, shorter than the limb; the primary *calyx-lobes* triangular, terminated by a *cusp* 0.1-0.5 mm. long, the secondary lobes truncate, ovate, and obtuse to slightly emarginate, about one-half as long as the primary lobes.

As others have pointed out, the extreme eastern Canadian thrifts are very variable, and it seems to me that only their partial geographic isolation has prevented the appearance of such an abundance of intermediate forms between them and other recognized variants of *A. maritima* as would render their present varietal position wholly untenable. For example, the correlation between the sheath length and head width is reasonably constant in these Canadian plants and exists in var. *sibirica* to a lesser degree. The same degree of constancy in these two characters is noted in some of the alpine European thrifts, but when the latter intermingle with other related units at lower elevations, the correlation ceases. The accurate separation of these northeastern Canadian plants from those of Alaska and of Greenland is often possible only when mature fruiting calyces are available.

Blake (1917) described the inner involucral bracts as "mucronate by the excurrent brown midrib at the rounded apex." The calyces from a large series were noted not to protrude conspicuously beyond the margin of the bract, as is the case in *A. maritima* var. *typica* of southern Greenland and of western Europe. The character of pubescence on the vertical calyx-ribs and connecting ribs is more consistent here than in any other unit of the species. With regard to the vesture of the calyces in the Labrador plants, Simmons (1906) stated:

> Their most noteworthy character is not mentioned in the description, viz., that the calyx is so minutely and scarcely perceptibly pubescent as to be nearly glabrous on the ribs as well as between them.

Malte (1934) conservatively disagreed, writing,

> . . . the statement, however, is not applicable to *A. labradorica* in general. Of all of the specimens from the Canadian arctic which have been examined—and they amount to several hundreds—the mature fruiting calyx is densely strigose with long, stiff hairs on the ribs and between them.

The writer's findings concur with Malte, but a plausible explanation of Simmon's statement may be that he studied flowering calyces and not those of specimens in fruit. As noted in the discussion of floral structures of the genus, vesture is one of the latest developments in the ontogeny of the calyx-tube. Specimens having only immature fruiting calyces are not common in the collections studied, but when encountered, usually require a magnification of about 20 diameters to show clearly the extent of pubescence. To those who wish to recognize *formae*, Blake's var. *submutica* and var. *genuina* may hold an appeal. I have made no attempt to recognize nomenclatorially the multiplicity of *formae* that exist in so variable a genus. In this regard, attention is invited to the fact that not only do Blake's lesser units have neither individual ranges of distribution nor constancy, but also as Malte has already observed (l. c., p. 186) calyces whose lobes are clearly referable to both elements have been found by him within a single head.

The western limits of distribution of this variant are known only imperfect-

ly. It is well established on the dry limestone barrens of northwestern Newfoundland and along the gravelly shores of Labrador and Baffin Land. In the Province of Quebec, it grows along the Hudson Strait and on the dry serpentine table-land barrens of Mt. Albert on the Gaspé Peninsula. Specimens have been collected in Keewatin, along the west side of Hudson Bay, along some of the tributaries feeding into Hudson Bay and in the Port Burwell, Port Harrison, and Richmond Gulf areas.

In July 1935, Professor C. W. Penland and J. D. Hartwell collected, for what is believed to be the first time, specimens of *Armeria* at Hoosier Pass, Park Co., Colorado. The one collection seen by me (Penland no. 1307) is not separable from var. *labradorica,* especially not from the forms found at the more northern range extensions of the latter. It is most difficult to believe that the var. *labradorica* would have such a disjunctive distribution and more material of the Colorado thrift is to be studied before final taxoonmic disposition of it is made.

Specimens examined:—HUDSON BAY: *Bell, R.*, no. 15818 (CAN, US); *Borden, L. E.*, no. 63012 (CAN); *Cope, T. M.*, Aug. 1934 (PH); *Gussow, W. C.*, July 1932 (OTB); *Johansen,* F., nos. 1049, 1202, 1255 (C); *Low, A. P.*, nos. 23028, 23437 (CAN); *Macoun, J. M.*, no. 79392 (CAN, GH, NY); *Malte, M. O.*, nos. 119112 (C, CAN), 119993 (CAN, GH), 120026 (CAN), 120035 (CAN, GH, MT), 120145 (CAN), 120158 (CAN, GH), 120244 (C, CAN, GH), 120459, 120528 (CAN, GH, NY); *Soper, J. D.*, no. 125849 (CAN); *Spreadborough,* no. 14418 (F, GH). BAFFIN LAND: *Bell, R.*, no. 18776 (CAN); *Hayes, I. I.*, no. 37 (US); *Malte, M. O.*, nos. 119107, 119795 (US); *Meehan, W. C.*, no. 52 (US); *Soper, J. D.*, Sept. 1926 (CAN); *Polunin, N.*, nos. 351 (GH), 454 (MO), 520 (GH), 660 (MO), 712 (US), 737 (F), 1175 (CAS), 1216, 1331 (F), 1398 (CAS), 2429 (NY), 560 (DS). LABRADOR: *Abbe, E. C. & M. C. D. Hogg,* no. 497 (CAN, GH), 498 (GH); *Anspach, G.*, no. 4756 (MO, PH); *Bartlett, R.*, no. 52 (US); *Bishop, H.*, 507a (CAN, GH), 507b (CAN, GH, US); *Bryant, O.*, Aug. 1908 (GH); *Erdman,* 1863 (NY); *Forbes, H. S.* ,Aug. 4, & Ang. 28, 1928 (GH); *Hayes, Dr.*, no. 35 (GH); Hinckley, F. C., Aug. 1911 (GH); *Morrison, B. R.*, Aug. 1934 (PH); *Palmer, S. C.*, Sept. 1929 (PH); *Polunin, N.*, no. 1061 (CAN); *Porsild, A. E.*, no. 251 (CAN); *Potter, D. & W. B. Brierly,* no. 3492 (GH, PH); *Schmitt, C. S.*, no. 38 (GH); *Sewall, C. S.*, nos. 24 (F, GH, NY, US), 149, 354 (F, GH); *Sewall, C. S. & A. C. Weed,* July 10, 1926 (F); *Soper, J. D.*, Sept. 1926 (CAN); *Stecker, A.*, nos. 112a (CAL), 112b (MO), 328 (GH, MO, NY); *Wetmore, R. H.*, no.103035 (CAN, GH); *Woodworth, R. H.*, no. 355 (GH). NEWFOUNDLAND: *Fernald, M. L. et al.*, nos. 1942, 1943 (GH), 3878 (GH, NY, PH), 26954 (CU, F, GH, NY, US); *Fernald, M. L. & B. Long,* no. 28884 (CU, GH, MT); *Fernald, M. L. & K. M. Wiegand,* nos. 3878a (CAN, CU, GH, NY, US), 3878b (F, GH, PH), 3879 (CU, GH), 3880 (CU, GH); *Jansson, K. P.*, Aug. 1930 (BH); *Kimball, R. H.*, no. 141 (GH); *Long, B. & J. M. Fogg, Jr.*, no. 374 (GH); *Mackenzie, K. K. & L. Griscom,* no. 10409 (GH, US); *Pease, A. S. & B. Long,* 28885 (GH); *Priest, M. E.*, July 1920 (GH); *Sanford, D. L. S.*, July 1911 (GH); *Stewart, C. C.*, no. 5149 (GH); *Waghorne, A. C.*, no. 29 (GH, MO); *Wiegand, K. M. et al.*, no. 28883 (CAN, CU, GH). EASTERN QUEBEC (Gaspé County, Mt. Albert): *Allen, J. A.*, July 1887 (GH, NY, PH); *Clausen, R. T. & H. Trapido,* no. 2878 (BH, CU); *Collins, J. F. & M. L. Fernald,* no. 127 (CAL, CAN, GH, MT, NY, US); *Fernald, M. L. et al.*, no. 25980 (CAN, GH, MT, NY, US); *Gosselin, A.*, Sept. 1935 (CAS); *Marie-Anslem,* no. 191 (OTB); *Marie-Victorin, Fr., et al.*, no. 17641 (MT); *Riley, C. G.*, Aug. 1935 (OTB); *Townsend, C. W.*, July 1922 (BH); *Wilson, W. C.*, no. 77 (BH).

4. A. MARITIMA (Mill.) Willd. var. INTERIOR (Raup) Lawr. in Gentes Herbarum 4:405, 1940.

Statice interior Raup in Journ. Arnold Arb. **27**:289, 1936.

The plant differs from typical *A. maritima* in *leaves* 2-6 cm. long and to 3.5 mm. wide, flat, glabrous; *scape* 10-18 cm. long; *sheath* 1.8-2.2 cm. long; *head* about 2 cm. across; *outer involucral bracts* ovate-oblong, acute, more than half as long as inner ones, but not longer than them; *inner involucral bracts* obtuse, margins broadly scarious to coriaceous; *pedicel* much shorter than calyx-tube; *calyx* entirely glabrous, the primary lobes triangular with cusp 1.2-1.4 mm. long, base of calyx obtuse.

The principal claim to distinctness of var. *interior* is to be found in its non-vestured calyx-tube, its long calyx-lobes and the relatively broad 1-nerved leaves; features known to be variable in other members of the genus and not considered cardinal characters for species delineation.

The plant is known only from the single collection by Raup, made at the type locality.

SASKATCHEWAN, Lake Athabaska: *Raup, H. M.*, no. 6895 (Type, GH; isotypes, BH, CAS).

5. A. MARITIMA (Mill.) Willd. var. PURPUREA (Mert. & Koch) Lawr. in Gentes Herbarum 4:405, 1940.

Statice Armeria L., pro parte Quod syn., Sp. Pl. ed. 1, p. 274, (1753).

Armeria vulgaris Willd. Enum. Hort. Berol. p. 333, (1809).

A. vulgaris Willd. var. *purpurea* Mert. & Koch in Roehling's Deutschl. Fl. **2**:488, (1826).

A. vulgaris Willd. f. *arctica* Cham., pro parte, Linnaea **6**:566, (1831).

A. arctica Wallr., pro parte, Beitr., Heft 1, 207, (1844).

A. campestris Wallr. *a Chamissoi* Wallr. Beitr. op. cit. p. 205.

S. arctica (Wallr.) Blake var. *genuina* Blake in Rhod. **19**:18, (1917).

A. vulgaris Willd. ssp *arctica* (Wallr.) Hultén, Fl. Aleut. Isls. p. 275, (1937).

A. scabra Willd. ssp. *arctica* (Cham.) Iversen in Danske Vidensk. Selskab., Biol. Meddel. **15**: no. 8, p. 18, (1940).

This variant differs from the typical element of *A. maritima* in the *leaves* 4-20 cm. long and 1.0-2.4 mm. wide, flat, margins glabrous or frequently ciliate along basal half, dorsal surface usually glabrous; *scape* 4-40 cm. long, glabrous to tomentose, usually as wide as leaves or wider; *head* 1.6-2.5 cm. across; *outer involucral bracts* ovate-elliptical, obtuse, narrowly or not at all membranous; *inner involucral bracts* usually obtuse, broadly membranous; *pedicel* as long as calyx-tube; *calyx-tube* ,pubescent on ribs, usually glabrous on connecting ribs and intercostal spaces, the latter generally narrower than the ribs; the *limb* usually longer than the tube; the *lobes* obtusely triangular to ovate, 0.6-1.6 mm. long, with *cusp* 0.4-0.8 mm. long.

Despite the study of several hundreds of collections, I have found no morphological characters that, singly or collectively, will separate the North American populations of this variety from those formerly known as the Old World *A. vulgaris* Willd. The acceptance of the hypothesis here presented, that the more southerly variants of *A. maritima* (sensu latiore) have been derived in part from the northern and nearly circumboreal var. *sibirica,* does not provide an answer to the perplexing problem of why two widely separated geographic races should seemingly be so indistinguishable from one another.[6] Statistical studies were made of a large number of specimens of each of these races to determine if differences or significant ratios might exist between them: none were obtained that showed any acceptable degree of constancy.

Following Blake, American authors have treated these plants as *A. arctica* (or *Statice arctica*). As shown by a free translation of Chamisso's original diagnosis of his *A. vulgaris* f. *arctica,* he considered it to differ from *A. vulgaris elongata* (a northern European variant of this complex) in:

> . . . leaves largely arising from a narrow base, standing nearly erect or spreading slightly and appearing as if expanded in the blade, not strictly linear as in the other, nor the stem much divided above the ground in a subshrubby cespitose habit.

Wallroth (pp. 193-194) raised Chamisso's name to specific rank, excluding the Labradorian material, but gave no new bases for distinction of his *A. arctica* from *A. vulgaris* Willd. (treated by him under his own and later name of *A. campestris*). Chamisso's characters for his forma *arctica* are pertinent except for his alleging the leaf blades to be non-linear. Attention is invited to the fact that plants from southern Scandinavia and from areas in the Baltic region are also characterized by the same features he gives for f. *arctica,* and it is interesting to note that a response to edaphic conditions appears to exist, for at the southern limits of distribution of the American and of the European material of var. *purpurea* the leaves are produced much more abundantly (no longer oligophyllus), are of greater length than more northern plants, and the plants become more diversely branched, multicipital and mound-forming. Plants of var. *sibirica* also have the suberect foliage ascribed by Chamisso to his f. *arctica,* as do also those of var. *interior.*

The var. *purpurea* differs from var. *californica* in that its outer involucral

---

6 The theory has been presented to me by Dr. H. G. Baker, University of Leeds, who read the manuscript of this paper, that perhaps the var. *purpurea* was a more heterogeneous thrift which, at some past age having a different climate, achieved a circumboreal distribution and that with the onset of the present climatic conditions the var. *sibirica* might be selected out as an ecotype which persists while temperate climates in the Old and New Worlds favor the existence of the similar biotypes represented by var. *purpurea.* Thus, var. *typica* would not have a polyphyletic origin but merely have become disjunct. This theory appears to be compatible with the situation as understood at present. Inasmuch as it is probable that the origin of the genus is in the Iberian peninsula, it is not concluded that var *sibirica* is the basically primitive type of *A. maritima* but rather that it is the element by means of which the present-day distribution of the species may be accounted. The var. *typica* and other elements of the species occur in the Iberian peninsula and it would be presumed by Dr. Baker's theory that var. *sibirica* evolved only after the northerly migration of the typical element.

bracts are shorter than the head and shorter than the inner ones and are infrequently lanceolate in outline; the heads are smaller, the leaves usually obtuse and also are frequently ciliate basally. This ciliate character is more conspicuous in the North American material than in the European, but is not considered to be sufficiently reliable for use in differentiating the plants. Intergradations with var. *sibirica* at the northern limits of var. *purpurea* are encountered, and many specimens have not been identified clearly with either variant. See notes under var. *californica* for discussion of intergradations with that element.

Specimens examined:—ALASKA (Kotzebue Sound to St. Lawrence Isl.): *Blaisdell, F. E.*, 1900 (NY); *Muir, J.*, no. 55 (GH); *Powers, Mrs. C. N.*, 1900-04, Apr. 1908 (UC); *W. E. B.*, Siskiyou Camp, 1902 (UC); *Wright, C.*, 1853-56 (GH). (St. Lawrence Isl. to Port Clarence): *Baranoff, M. A.*, no. 29 (WTU); *Brenner*, no. 4773 (MO); *Geist, O. W.*, July-Aug. 1931 (UC); *Hagelberger, M. W.*, 1871-72 (GH); *Jones, G. N.*, no. 9175 (CAS, DS, OSC, WTU); *Macoun, J. M.*, July 1891 (CAN, GH, NY); July 1897 (CAN); *Merriam, C. H.*, Aug. 1891 (NY); *Rutter, C.*, no. 59 (F, GH, NY); *True, F. W. & D. W. Prentiss, Jr.*, no. 103 (NY); *White, R.*, (NY). (Port Clarence southward): *Bryant, Mrs.* 1876 (PH); *Bryant, W. E.*, July-Aug. 1903 (UC); *DeVoe, J.*, July 1934 (CAS); *Eicher, G. & G. M. Powell*, 1939 (OSC); *Eyerdam, W. J.*, no. 2182 (CAS, NY); *Fernow, B. E.*, July 1899 (CU); *Haley, G.*, 1919, June 1926 (CAS); *Hanna, G. D.*, July 1920 (CAS); *Harrington, M. A.*, July 1872 (GH, MO,NY, PH); *Heath, H.*, June-Aug. 1910 (DS); summer 1917 (CAS), July 1917 (DS); *Johnston*, June-July 1914, July 1922, June 1930 (CAS); *Kellere, H. D.*, July 1914 (CAS); *Muir, J.*, no. 41 (GH); *Murie, O. J.*, Aug. 1925 (GH); *Porsild, A. E. & R. T.*, no. 1389 (MT); *Trelease, W. & D. Saunders*, nos. 4772, 4774 (MO); *Rutter, C.*, no. 86 (CAS); *Scale, A.*, July 1896 (DS). VANCOUVER ISLAND, B. C.: *Gardner, N. L.*, no date (UC); *James, F. J.*, June 1911 (GH); *Lyall*, 1858 (GH); *Macoun, J. M.*, nos. 643 (MO), 1198 (F), 86340 (NY); *Pineo, A. J.*, May 1899 (UC); *Rosendahl, C. O. & C. J. Brand*, no. 19 in part (CAN, DS, MO). WASHINGTON (Clallam Co.): *Elmer, A. D. E.*, no. 2448 (DS, WTU); *Webster*, E. B., summer 1909 (LA, WTU). (Pacific Co.): *Bailey*, June 1900 (LA) (San Juan Co.): *Beattie, R. K.*, no. 3303 (WTC); *Muenscher, W. C.*, no. 789 (CU); *Pope, T. S.*, June 1904 (WTU); *Zeller, S. M. et ux.*, no. 868 (GH, LA, MO, NY, US). (Skagit Co.): *Hardin, E.*, May 1925 (WTC). (Island Co.): *Hitchcock, C. L.*, no. 3450 in part (LA). (King Co.): *Shumway, E. A.*, summer 1888 (WTU). (Pierce Co.): *Allan, O. D.*, no. 96 (GH); *Eyerdam, W. J.*, May 1937 (WTC); *Fleet, J. B.*, May 1895 (CU); *Jones, G. N.*, no. 4649 (WTC, WTU). (Thurston Co.): *Foster, A. S.*, no. 219 (NY); *Otis, I. C.*, no. 1864 (WTC); *Piper, C. V.*, no. 147 in part (WTU).

6. A. MARITIMA (Mill.) Willd. var. CALIFORNICA (Boiss.) Lawr. in Gentes Herbarum **4**:406, 1940.

Statice Armeria L., pro parte (sensu many Amer. auth.), Sp. Pl. ed. 1, p. 274, (1753).

Armeria andina Poeppig ex Boiss. var. *californica* Boiss. in DC. Prod. **12**:682, (1848).

S. Armeria L. var. *arctica* (Cham.) Simmons, pro parte, in Acta Univ. Lund. n.s. **9**:121, (1913).

S. arctica (Cham.) Blake var. *californica* (Boiss.) Blake in Rhod. **19**:18, (1917).

A. macloviana Cham. ssp. *californica* (Boiss.) Iversen in Danske Vidensk Selskab., Biol. Meddel. **15**: no. 8, p. 18, (1940).

Differs from the typical element of *A. maritima* primarily in the *leaves* 6-12 cm. long and 1.2-2.5 mm. wide, often ascending or slightly fasciculate about the stem, flat, usually obtuse and very rarely acute or apiculate, glabrous; *head*

1.8-2.6 cm. wide; *outer involucral bracts* broadly linear-triangulate to oblong-lanceolate, acute or bluntly so, often equalling or exceeding the head; *inner involucral bracts* ovate, obtuse to acute, shorter than the outer ones or predominately so; *calyx-tube* pubescent on vertical ribs and glabrous on connecting ribs and intercostal spaces; the *lobes* obtuse or triangular, rarely truncate; the *cusp* 0.1-0.6 mm. long.

Despite a criticism, by several botanists, of Blake's distinction between his var. *genuina* and var. *californica,* the writer believes the two to be sufficiently distinct to warrant their varietal recognition. Critics, cf. Jones (1936), have quite obviously assumed these varieties to be geographical as well as morphological entities, which in a strict sense they are not. Both variants are found to intermingle with each other in the vicinity of Vancouver Isl., B. C., and the Puget Sound area in Washington. Individuals showing unmistakable affinity with the northern var. *purpurea* have been collected in northern California.

The var. *californica* is very similar in many respects to *A. maritima* var. *elongata* (Koch) Lawr. of northwestern Europe, particularly with regard to its height of scape, the elongate outer involucral bracts and general aspect. In foliage, it resembles several of the South American (Chilean) elements of this same polymorphic species and with which it is undoubtedly related. The character of the triangular-lanceolate and usually long outer involucral bracts, the larger heads and foliage also serve to distinguish it from populations of var. *purpurea* at the northern limits of its range. The glabrous leaves of var. *californica* are usually constant in this respect and not ciliate as in var. *purpurea.*

Following the citation of specimens of this variety is given the citation of those specimens intermediate between it and var. *purpurea* and which cannot be placed under either variant.

Specimens examined:—VANCOUVER ISLAND, B. C.: *Anderson, J. R.,* June 1916 (WTC); *Carter, W. R.,* May 1917 (GH, US); *Eastham, J. W.,* July 1938 (OTB); *Hitchcock, C. L.,* no. 3450 in part (CAS, WTU); *Maccun, J. M.,* nos. 643 in part (US), May 1897 (CAN, NY, US), 86340 in part (CAN, F, GH, MO), 87098 (US); *Rosendahl, C. O. & C. J. Brand,* no. 19 in part (NY, PH, UC, US). WASHINGTON (Clallam Co.): *Almey, A. D. E.,* no. 2448 (NY); *Hitchcock, C. L.,* no. 3556 in part (WTC, WTU); *Lawrence, D. H.,* no. 260 (WTC). (Jefferson Co.): *Cannon, E.,* no date (WTC); *Kellogg, A.,* Port Townsend (NY). (Pacific Co.): *Spiegelberg, H.,* no. 693 (WTC). (Gray's Harbor Co.): *Grant, J. M.,* June 1917 (NY). (Whatcom Co.): *Muenscher, W. C.,* no. 8334 (WTC); *Muenscher, W. C. & M. W.,* no. 6031 (CU, WTC). (San Juan Co.): *Frye, T. C.,* June 1904 (WTU); *Roush, L.,* June 1919 (DS). (Skagit Co.): *Brown, R. H.,* June 1922 (WTC). (Island Co.): *Gardner, N. L.,* July 1896 (UC); *Grant, J. M.,* (UC); *Hitchcock, C. L.,* no. 3450 in part (CAS, WTU); *Smith, H. W.,* no. 518 (WTC); *Thompson, J. W.,* no. 6046 (OSC, UC, WTU). (Snohomish Co.): *Grant, J. M.,* May 1930 (L, UC). (Pierce Co.): *Eyerdam, W. J.,* May 1937 (F). (Thurston Co.): *Smith, E. C.,* Aug. 1889 (MO); *Townsend, E. C.,* May 1906 (WTC). OREGON (Clatsop Co.): *Abrams, L. R.,* no. 8882 (DS); *Brown, R., & G. M. Powell,* Sept. 1935 (OSC); *Henderson, L. F.,* no. 640 (DS, OSC, UC); *M. W. G.,* no. 1935 (WTU). (Tillamook Co.): *Morrill, G. E.,* no. 116 (WTU); *Peck, M. E.,* no. 7014 (WILLU). (Lincoln Co.): *Buhl, C.,* no. 26 (F); *Gilkey, H. M.,* July 1912 (WTU); *Gilkey, Rees, & Fleishman,* June 1943 (DS, OSC, WTC); *Nelson, J. C.,* no. 2343 (GH); *Owens, C. E., & G. M. Cole,* May 1914 (OSC); *Powell, G. M.,* Aug. 1939 (OSC). (Coos Co.): *Haydon, W.,* Aug. 1911 (CAS); *Henderson, L. F.,*

no. 13755 (PH); *House, H. D.*, no. 5025 (NY); *Muenscher, M. W.*, no. 5564 (CU); *Scullen, H. A.*, no. 109 (OSC); *Thompson, J. W.*, no. 4415 (DS, PH, US, WILLU), no. 12798 (PH, US, WTC, WTU). (Curry Co.): *Baldwin, E., & G. M. Powell*, June 1932 ((OSC); *Howell, T.*, June 1884 (F, GH, NY, PH, US, WTU); *Hoyt*, J. W., no. 106 (DS); *Kildare, D. K.*, no. 8530 (DS); *Peck, M. E.*, no. 7013 (WILLU), no. 8439 (GH, NY), 23975 (WILLU); *Thompson, J. H.*, no. 135 (DS); *Thompson, J. W.*, no. 4459 (DS, WTU). Multnomah Co.): *Palmer, W.*, 1905 (NY, US). (Yamhill Co.): *Summers, Mrs. R. W.*, no. 2045 (UC). CALIFORNIA (Del Norte Co.): *Eastwood, A.*, no. 260 (CAS); *Kelly, G. E.*, June 1924 (CAS). (Humboldt Co.): *Chandler, H. P.*, no. 1153 (UC); *Dudley, W. R.*, June 1889 (DS); *Tracy, J. P.*, no. 4649 (MO, NY, UC), no. 8115 (DS, UC). Mendocino Co.): *Brown, H. E.*, no. 832 (F, MO, NY, PH, UC, US); *Constance, L.*, no. 2494 (DS, WTC); *Duncan, C. D.*, no. 166 (DS, PH); *Eastwood, A.*, no. 1747 (CAS); *Jones, M. E.*, no. 20215 (DS, MO, UC); *Keck, D. D.*, no. 4750 (DS); *Murphy, J.*, no. 219 (DS). (Sonoma Co.): *Baker, M. S.*, 1899 (UC); *Brandegee, K.*, June 1905 (UC); *Eastwood, A.*, no. 4808 (CAS, GH); *Eastwood, A. & J. T. Howell*, no. 7372 (CAS). (Marin Co.): *Baker, C. F.*, no. 2851 (F, GH, MO, NY, UC, US); *Bigelow*, Apr.-May (GH); *Bracelin, Mrs. H. P.*, no. 18 (DS, GH, UC, US); *Collins, J. F.*, Apr. 1918 (GH); *Davy, J. B.*, no. 821 (UC), 6878 (UC); *Engelmann, G.*, July 1880 (MO); *Hartweg*, no. 1927 (GH, NY); *Howell, J. T.*, no. 1958 (CAS); *Jones, M. E.*, no. 3261 (CAS, DS, MO, NY, US); *Mann, H.*, (F); *Mason, H. L.*, no. 2867 (UC); *Norton, Miss M. E. B.*, (F); *Ottley, A. M.*, no. 412 (CU); *Rattan, V.*, Feb. 1877 (DS); *Seffer, P. O.*, 1904 (DS); *Tidestrom, I.*, May 1895 (UC). (Alameda Co.): *Mann, H.*, no. 21 (F). (San Mateo Co.): *Benson, L.*, no. 2149 (WTU); *Brewer, W. H.*, no. 650 (UC); *Eastwood, A.*, no. 4712 (CAS, GH); *Wiggins, I. L.*, no. 3801 (LA); *Williamson, C. S.*, July 19-- (PH). (Santa Cruz Co.): *Berg, N. K.*, Feb. 1904 (UC); *Hesse, V. F.*, no. 454 (DS); *Setchell, W. A.*, Apr. 1897 (UC). (Monterey Co.): *Abbott, E. K.*, 1899 (CAS, NY); *Berg, N. K.*, May 1904 (UC); *Chandler, H. P.*, no. 325 (UC); *Coleman, G. A.*, July 1905 (DS); *Condit, I. J.*, no. 16 (UC); *Douglas, G. E.*, no. 83 (GH); *Dudley, W. R.*, Apr. 1894 (DS); *Eastwood, A.*, no. 87 (CAS); *Elmer, A. D. E.*, no. 4385 (CAS, DS, MO, OSC, NY, UC, WTC); *Epling, M. & C. C.*, no. 8366 (LA); *Heller, A. A.*, no. 6641 (DS, F, GH, MO, PH, US); *Jackson, B. R.*, 1930 (CAS); *Jenkins, O.*, July 1907 (DS); *Kraus, E. J.*, July 1924 (MT); *Lemon Herb.*, May 1928 (UC); *McGregor, S. A.*, no. 45 (DS); *Michener & Bioletti*, no. 194 (GH); *Newell, C.*, June 1903 (GH); *Ottley, A. M.*, no. 1308 (CU); *Parish, S. B.*, no. 11451 (UC); *Paterson & Wiltz*, June 1907 (DS, UC); *Peirson, F. W.*, no. 3804 (DS); *Randall, A. D.*, no. 429 (DS), Mar. 1910 (DS); *Randall, J. D.*, Mar. 1911 (DS, NY); *Upton, L. N. & G. B.*, May 1930 (CU); *Wiegand, K. M. et al.*, no. 1901 (CU, F). (San Luis Obispo Co.): *Eastwood, A.*, no. 13667 (CAS); *Keck, D. D.*, no. 2186 (DS); *Palmer, E.*, no. 308 (F); *Winblad, Y. W.*, June 1937 (CAS). (Santa Barbara Co.): *Hoffman, R.*, May 1932 (CAS). (San Diego Co.): *Herre, A. C.*, July 1902 (DS); *Nuttall, T.*, no date (PH). (Santa Clara Co.): *Dudley, W. R.*, Apr. 1896 (DS); *Grant, A. L.*, no. 940 (DS).

Specimens determined to be intermediate between *A. maritima* var. *purpurea* and var. *californica* are represented by the following collections: VANCOUVER, B. C.: *Anderson, J. R.*, no date (WTC); *Eastwood, A.*, no. 9739 (CAS); *Warren, E. M.*, June 1916 (OTB). WASHINGTON (Clallam Co.) *Grant, J. M.*, May 1916 (WTU); *Hitchcock, C. L.*, no. 3556 in part (DS), 10589 (WTU).| (San Juan Co.): *Lawrence, W. H.*, no. 201 (WTC, WTU). (Island Co.): *Gardner, N. L.*, May 1897 (WTU); *Jones, G. N.*, no. 4902 (WTU); *Smith, H. W.*, no. 823 (WTU); *St. John, H.*, no. 7918 (DS, WTC). (Snohomish Co.): *Grant, J. M.*, June 1928 (DS). (Pierce Co.): *Fleet, J. B.*, May 1895 (WTU); *Thompson, J. W.*, no. 8239 (WTU). Thurston Co.): *Kinkaid, T.*, July 1896 (WTC); *Otis, I. C.*, no. 1864 (WTU).

Note: one collection from the dunes near Samoa, Humboldt Co., California, (Wiggins, I. L. no. 4683, DS) has the vegetative characteristics of var. *california*, but the small heads and involucral bracts of the northern var. *purpurea*.

REFERENCES

BABINGTON, C. C. 1849—English Botany. London.

BLAKE, S. F. 1917—Statice in North America. Rhodora **19**:1-19.

BÖCHER, T. W. 1938—Biological Distributional Types in the Flora of Greenland. Meddel. om Grønl. **106**: no. 2.

BOISSIER, E. 1848—Armeria. *In* DeCandolle, A. P. & A., Prodromus Systematis Naturalis Regni Vegetabilis **12**:674-689.

BRIQUET, J., ET AL. 1935—International Rules of Botanical Nomenclature. Ed. 3, rev., Jena.

CHAMISSO, L. C. A. VON. 1831—Armeria vulgaris Willd. f. arctica. Flora **6**:566.

DRUCE, G. C. 1901—On the British Species of Sea-thrifts and Sea-lavenders. Journ. Linn. Soc. Lond. **35**:66-67.

ERDTMAN, G. 1940—Flower dimorphism in *Statice Armeria* L. Svensk Bot. Tidskrift **34**:377-380.

GELTING, P. 1934—Studies on the Vascular Plants of East Greenland, etc. Meddel. om Grønl. **101**:1-340.

GRENIER, J. C. M. & D. A. GODRON. 1852—Flore de France, vol. 2.

HOOKER, J. D. 1844—Flore Antarctica, vol. 1.

HULTEN, E. 1937—Flore of the Aleutian Islands, pp. 275-276. Stockholm.

IVERSEN, J., 1940—Blütenbiologische Studien, I. Dimorphie und Monomorphie bei Armeria. Kgl. Danske Vidensk. Selskab., Biol. Meddel. **15**(8):1-39.

JACKSON, B. D. 1912—Index to the Linnaean Herbarium. London.

JONES, G. N. 1936—Botanical Survey of the Olympic Peninsula. Univ. of Wash. Publ. in Biol. **5**.

LAWRENCE, G. H. M. 1940—Armeria. Gentes Herbarum **4**:391-419.

MALTE, M. O. 1934—Critical Notes on Plants of Arctic America. Rhodora **36**:172-193.

MILLER, P. 1768—The Gardener's Dictionary, ed. 8.

POLUNIN, N. 1940—Botany of the Canadian Eastern Arctic, Part I. Natl. Mus. Can. Bull. **92**.

RAUP, H. M. 1936—Phytogeographic Studies in the Athabaska-Great Slave Lake Region. Journ. Arnold Arb. **17**:289.

ROSENVINGE, L. K. 1892—Andet Tillaeg td Grønlands Fanerogamer og Karsporeplanter. Meddel. om Grønl. **3**:683.

SIMMONS, H. G. 1906—The Vascular Plants in the Flora of Ellesmereland. Report of the Second Norwegian Arctic Expedition of the "Fram."

SOLONEVICZ, K. I. & A. A. KORCZAGINE. 1934—Fossils of the Arctic Flora near the Town of Totma Sovietskaia Botanika **1934**(5):151-152. (Title, a translation from the Russian).

SYME, BOSWELL. 1867—English Botany, vol. 7.

SZAFER, W. 1945—Kopalna *Armeria* w Plejstocenie Europejskim ze Szczegolnym Uwzgladnierien Plejstocenu w Polsce. (The Fossil Armeria in the European Pleistocene especially in Poland). Starunia **20**:1-3-. [*Not seen by author.*]

———1946—Rodzaj *Armeria* Willd. w Polsce. (La genre Armeria en Pologne). Acta Soc. Bot. Polon. **17**:7-28.

TURESSON, G. 1922—The Genotypical Response of the Plant. Hereditas **3**:265-275.

WALLROTH, F. W. 1844—Beiträge zur Botanik. Heft 2. Leipzig.

WILLDENOW, C. L. 1809—Enumeratio Plantarum Horti Regni Botanici Berolinensis, p. 333.

BAILEY HORTORIUM,
CORNELL UNIVERSITY,
ITHACA, N. Y.

The Genus Parosela (Sect. Aureae) in Texas

B. C. Tharp and Fred A. Barkley

In reviewing the material of the section AUREAE of the genus *Parosela* in the University of Texas Herbarium it became obvious that much confusion had occurred in the determination of *Parosela aurea* (Nutt.) Britt., *P. nana* (Torr.) Heller, and *P. Wrightii* (A. Gray) Vail.

A careful study of material shows that *P. nana,* while often low and with the stems leafy, is nearly as often tall with the leaves somewhat reduced above. The peduncles are from 1 to 3 cm long. A misunderstanding of the variation in *P. nana* has meant that many specimens of that species are "keyed" to *P. aurea,* which differs from *P. nana* in many respects. In aspect *P. aura* is the much coarser plant.

A study of the material included with *P. Wrightii* showed four entities which seemed specifically distinct. Descriptions of these were recently published,* but it seems desirable to publish the additional illustrations which are included here.

The following key modified from Rydberg's treatment in *North American Flora* (24:70. 1920) seems to separate satisfactorily the specimens which have been examined.

A. Leaves 3-foliolate.

- B. Leaflets linear or linear-oblanceolate, sparsely appressed silky-canescent; heads subsessile; stems 3 to 4 dm high, leaves comparatively few .... *P. Hallii*
- B. Leaflets obovate or oblanceolate.
  - C. Heads sessile or subsessile; stems erect, .2-.3 dm high, densely leaved; densely ferrugineously canescent .... *P. Jamesii*
  - C. Heads with peduncles 2-5 cm long; stems erect, 1-4 cm high, few-leaved; sparsely appressed silky-canescent .... *P. rubescens*

A. Leaves 5-foliolate; leaflets sericeous on both sides and usually obscurely glandularly dotted.

- B. Stems 3-5 dm high, with the upper leaves reduced and spikes rather long-peduncled; plant coarse .... *P. aurea*
- B. Stems 1-2 dm high (in *P. nana* to 4 dm high), often decumbent at the base; spikes sessile or short-peduncled (in *P. nana* peduncle 1-3 cm long).
  - C. Peduncles 1-3 cm long; bracts ovate, short acuminate; spikes about 1 cm thick; leaflets broadly oblanceolate to obovate, rounded to subacute; leaves often somewhat reduced above; stems slender .... *P. nana*
  - C. Peduncles to .5 cm long; bracts lanceolate, usually long acuminate; leaves scarcely reduced above.
    - D. Spikes 1.5 to 2 cm thick.
      - E. Plants about 2 dm tall; leaflets lanceolate-acuminate, strigose-setaceous; spikes about 1.8 cm thick; bracts broadly lanceolate .... *P. Wrightii*

---

* An. Esc. Nac. Cienc. Biol. (Mex.) **4**(2/3):283-287, 1946.

E. Plants about 1 dm tall; leaflets ovate, obtuse to acute, lanuginose-sericeous, spikes about 2 cm thick; bracts narrowly lanceolate .... *P. Warnockii*

D. Spikes about 1 cm thick.

E. Spikes about 1 cm long; leaves 1.5 cm long; plant scarcely 1 dm high; leaflets ovate, acute, densely sericeous ....*P. Whitehouseae*

E. Spikes mostly over 2 cm long; leaves over 2 cm long; plant about 1.8 dm high; leaflets ovate, acute, sparsely sericeous ....*P. LeSueuri*

PAROSELA WHITEHOUSEAE Tharp & Barkley,

An. Esc. Nac. Cienc. Biol. (Mex.) 4:285. 1946

Low perennial with woody taproot and short caudex; stems few, 4-10 cm tall, silky canescent, leafy; leaves 5- (rarely 3-7-) foliolate, 8-12 mm long; stipules subulate, about 1 mm long; petiole about 4 mm long, sparsely glandular, sparsely sericeous; rachis glandular, sparsely sericeous; leaflets narrowly obovate, 3-5 mm long, densely sericeous, subacute; spikes subsessile at the ends of stems, 1-1.2 cm long, about 1 cm thick; bracts narrowly ovate, acuminate, about 4.5 mm long, shorter than the calyx; calyx tube turbinate, obscurely 10-ribbed, about 2.5 mm long, densely silky; lobes filiform from a broad base, plumose, about 3.5 mm long; corolla yellow, fading to a rose-color; blade of banner about 3 mm broad, 2 mm long, cordate flabellate, the claw about 2.5 mm long; wings and keel petals inserted a little above the middle of the staminal-tube; pods long-pubescent, about 3 mm long.

TYPE: Mesquite chaparral savanna, Menard County, Texas, July 7, 1928, *B. C. Tharp s.n.* in the University of Texas Herbarium.

Fig. 1.—The type specimens of *Parosela Whitehouseae* Tharp & Barkley, mesquite chaparral savanna, Menard County, Texas, July 7, 1928, in the University of Texas Herbarium. Note the delicate woody taproot, the short, slender stems, the globose spikes and the small leaves. (Photograph by Warnock.)

Fig. 2.—The type specimen of *Parosela LeSueuri* Tharp & Barkley, Stockton to Sheffield, Pecos County, Texas, June 3, 1940, in the University of Texas Herbarium. Note the slender woody taproot, the several stems, the size and shape of the leaflets, and the size and shape of the spikes. (Photograph by Warnock.)

PAROSELA LESUEURI Tharp & Barkley,
An. Esc. Nac. Cienc. Biol. (Mex.) 4:286. 1946

Low biennial or perennial with woody root and short caudex; stems several, about 2 dm long, sparsely silky canescent, leafy; leaves pinnately 5- (rarely 3-7-) foliate, 1.7-2.5 cm long; stipules subulate 1.5-2 mm long; petiole about 7 mm long, sparsely glandular, sparsely sericeous; rachis sparsely sericeous, sparsely glandular; leaflets obovate, 5-7 mm long, sericeous but sparsely so above, subacute to rounded; spikes subsessile at the ends of stems,

Fig. 3.—The type specimen of *Parosela Warnockii* Tharp & Barkley, Stockton to Sheffield, Pecos County, Texas, June 3, 1940, in the University of Texas Herbarium. Note the short stocky stature of the plant, the ovate and obtuse to subacute leaflets, and the coarse spike. (Photograph by Warnock.)

1.5-2.5 cm long, about 1 cm thick; bracts lanceolaate, acuminate, about 6 mm long, longer than the calyx; calyx tube turbinate, obscurely 10-ribbed, 2-5 mm long, silky; calyx lobes subulate-acuminate from a broad base, about 3.5 mm long, silky-plumose; corolla yellow, fading to rose-color; blade of banner 2 mm broad, .8 mm high, cordate-flabellate, claw about 1.5 mm long; wings and keel petals inserted about the middle of the staminal tube; pods long-pubescent above.

TYPE: Stockton to Sheffield, Texas, June 3, 1940, *B. C. Tharp s.n.* in the University of Texas Herbarium.

PAROSELA WARNOCKII Tharp & Barkley,
An. Esc. Nac. Cienc. Biol. (Mex.) 4:284. 1946

A low perennial with a slender woody taproot and short caudex; stems few to several, rarely over 1 dm long (exclusive of the inflorescence), densely silky-canescent, leafy; leaves pinnately 5-foliolate (rarely 3-7-foliolate), 1-4 cm long; stipules subulate, 5-7 mm long; petiole about 8 mm long, sericeous; rachis sericeous, obscurely glandular punctate; leaves broadly obovate, .5.1.5 cm long, .4-1 cm broad, silky-canescent on both sides; spikes sessile at the ends of stems, 2.5-7 cm long, over 2 cm thick; bracts lanceolate, acuminate, longer than the calyx, sparsely glandular-dotted; calyx turbinate, 10-ribbed, about 4 mm long, densely silky; lobes filiform from a broad base, plumose, about 7 mm long; corolla yellowish; blade of the banner 2.5 mm long, nearly 6 mm broad, cordate-flabellate, the claw 5 mm long; wings and keel petals inserted a little above the middle of the staminal tube; pod villous pubescent near the apex, about 4 mm long.

TYPE: Stockton to Sheffield, Texas, June 3, 1940, *B. C. Tharp s.n.* in the University of Texas Herbarium.

DEPARTMENT OF BOTANY AND BACTERIOLOGY,
UNIVERSITY OF TEXAS,
AUSTIN, TEXAS.

Supplementary List of Illinois Vascular Plants

George Neville Jones

This list comprises twenty-eight species of vascular plants that were not included in the *Flora of Illinois*, published in 1945. From a phytogeographical standpoint it contains two classes of plants, some that are adventive weeds and garden escapes, and others that are native, mostly rare species, such as *Bergia texana, Echinodorus tenellus, Heteranthera limosa, Scirpus hallii,* and *Spiranthes lucida.* Some of these have not been seen in Illinois for more than half a century, and may perhaps have become extinct here. Unless otherwise indicated, the specimens are in the herbarium of the University of Illinois. For opportunity of checking various specimens, thanks are due Drs. J. M. Greenman of Missouri Botanical Garden, E. J. Palmer of Arnold Arboretum, P. C. Standley and J. A. Steyermark of Chicago Natural History Museum, H. K. Gloyd of Chicago Academy of Sciences, L. R. Tehon of Illinois Natural History Survey, V. H. Chase of Peoria Academy of Science, and George D. Fuller of Illinois State Museum at Springfield.

Aegilops cylindrica Host.—Along railroad, Champaign, June 24, 1935, *H. J. Fuller;* along railroad, Quincy, *R. A. Evers & G. N. Jones* 1190.

Bergia texana (Hook.) Seubert.—Southern Illinois, rare. Near Cahokia, *H. Eggert* in 1874 (MBG); St. Clair Co., *H. Eggert* in 1878 (MBG).

Chamaelirium luteum (L.) A. Gray.—Seven miles northwest of Metropolis, Massac Co., May 18, 1932, *Pepoon & Barrett* 3768 (herb. Ill. Nat. Hist. Surv.).

Corallorhiza wisteriana Conrad.—Carlinville, *W. E. Andrews* in 1891; Sugarloaf, *Woodson & Stevenson* in 1926 (MBG); Mounds, Pulaski Co., *E. J. Palmer* 14870 (MBG); French Village, St. Clair Co., May 8, 1892, *H. Eggert* (MBG).

Descurainia sophia (L.) Webb.—Waste places, not common; adventive from Europe. Winnebago Co., *M. S. Bebb* in 1873; along railroad, Sycamore, DeKalb Co., *G. N. Jones* in 1945.

Dianthus armeria L.—Weed in pasture, Urbana, *G. N. Jones* 17531.

Echinodorus tenellus (Mart.) Buch.—Wet places, St. Clair Co., August 11, 1892, *H. Eggert* (MBG).

Erysimum inconspicuum (S. Wats.) MacM. — Dry soil, not common. Stark Co., *V. H. Chase* in 1905 ("a recent introduction."); Joliet, June 4, 1908, *E. J. Hill;* Hanover, Jo Daviess Co., *G. N. Jones* in 1945.

Eupatorium incarnatum Walt. — Low woods, McClure, Alexander Co., September 29, 1919, *E. J. Palmer* 16613 (MBG); rich woods, Mounds, Pulaski Co., September 24, 1919, *E. J. Palmer* 16563 (MBG).

Froelichia gracilis Moq.—Weed along railroad, Urbana, *R. A. Evers* 1455, 1571, *G. N. Jones* 17489.

Houstonia nigricans (Lam.) Fern. — Eldred, Greene Co., July 4, 1889, *W. E. Andrews;* Pere Marquette State Park, Jersey Co., July 8, 1939, *Geo. D. Fuller & G. M. Link* 168, 457.

Houstonia pusilla Schoepf.—Dixon Springs, Pope Co., *E. W. & G. B. Fell,* April 13, 1946; Alto Pass, Union Co., *H. S. Pepoon* 3172; Bosky Dell, Jackson Co., *G. D. Fuller & W. B. Welch* 624.

Iresine rhizomatosa Standl.—Wabash Co., October 5, 1895, *J. Schneck.*

Heteranthera limosa (Sw.) Willd.—Low grounds, Indian Lake, September 23, 1886, *Pammel* (MBG); muddy places opposite St. Louis, July 1839, *Engelmann* (MBG); margins of sloughs, American Bottom, August 1838, *Engelmann* (MBG); St. Clair Co., August 2, 1877, *Eggert* (MBG); East St. Louis, July 5, 1896, *Eggert* (MBG).

Monarda didyma L.—A large colony in dense woods, Biltmore Estate, five miles north of Barrington, July 13, 1946, *J. A. Steyermark* 63888. In 1891, Higley & Raddin reported a few specimens from South Chicago.

Plantago arenaria W. & K.—North Chicago, September 1, 1933, *O. C. Durham* (CM); Crystal Lake, McHenry Co., September 3, 1942, *H. C. Benke* 6191 (CM); gravelly roadbed, Champaign, August 5, 1933, *H. S. Pepoon* (CM).

Polygonum longisetum DeBruyn.—Moist shaded ground, campus of the University of Illinois, Urbana, *G. N. Jones* 16399, 17391. (Determined by Mr. C. A. Weatherby.)

Prunus munsoniana Wight & Hedr.—Golconda, Pope Co., *E. J. Palmer* 15388 (MBG); Tunnel Hill, Johnson Co., *E. J. Palmer* 15236 (MBG); East Cape Girardeau, Alexander Co., *E. J. Palmer* 14897 (MBG); Cairo, Alexander Co., *E. J. Palmer* 14887 (MBG); St. Clair Co., April 13, 1896, *H. Eggert* (MBG).

Pyrola americana Sweet.—Near Oregon, Ogle Co., April 7, 1946, *G. D. Fuller* 12102; *E. W. & G. B. Fell,* June 28, 1946.

Sabatia campestris Nutt.—Prairie soil, rare. Peoria, *F. E. McDonald;* Washington Co., *H. Eggert* (MBG); without locality, *Riehl* (MBG).

Salix wardi Bebb.—Horseshoe Lake, five miles east of Venice, Madison Co., June 27, 1895, *N. M. Glatfelter* (MBG); Cahokia, Madison Co., April 16, 1887, *H. Eggert* (MBG); east of Belleville, St. Clair Co., August 20, 1849, *G. Engelmann* (MBG).

Salvia pratensis L.—Escaped along North Hill Drive in open woods, Biltmore Estate, five miles north of Barrington, Lake Co., June 15, 1946, *J. A. Steyermark* 63727 (CM).

Scirpus hallii A. Gray.—Type locality: Menard Co., Illinois. Originally cited, by mistake, as Mason Co. Collected by E. Hall. Type in the Gray Herbarium. Reported by Patterson (1876), and by Brendel (1887), but apparently not recently collected in Illinois.

Scirpus heterochaetus Chase. — Athens, *E. Hall*, July, 1869 (CM); Oquawka, *H. N. Patterson* (CM); Dupo, *Steyermark* 4471 (CM).

Solidago uliginosa Nutt. Boggy swamp, two miles northwest of Irene, Boone Co., August 23, 1946, *Geo. D. Fuller* 11873; boggy wet prairie, three miles west of West Beloit, Winnebago Co., August 24, 1946, *Geo. D. Fuller* 11954.

Spigelia marilandica L.—Woods and thickets, southern Illinois, extending northwestward to Jefferson Co. Specimens examined from Jackson, Jefferson, Johnson, Massac, Pope, Pulaski, Saline, Union, and White counties.

Spiranthes lucida (A. A. Eaton) Ames.—Springy bog in wooded pasture, southeast of Marley, Will Co., June 22, 1897, *Agnes Chase* (Chicago Acad. Sci. Herb.).

Tragia cordata Michx.—Reported as *T. macrocarpa* by Patterson (1876) from "Banks of the Ohio at Golconda, Pope County, Forbes." Rocky woods bordering Ohio River, Golconda, *E. J. Palmer* 19582 (MBG).

Corrections to "Flora of Illinois"

Page 15, line 7 from bottom, read: 125A instead of 126.
Page 25, line 21 from bottom, delete: finely pubescent.
Page 34, last line, read: 5. *Dennstaedtia* instead of 3.
Page 35, line 4, read: 3. *Cystopteris* instead of 5.
line 8 from bottom, read: 15. *Cryptogramma* instead of 14.
line 6 from bottom, read: 16. *Pellaea* instead of 15.
Page 54, line 23, read: *M. nitens* (Scribn.) Piper instead of Nutt.
Page 72, line 20, read: *pauciflorus* instead of *pauciflora*.
Page 84, line 16, delete: beak of the perigynium sparsely serrulate;
line 17, read: *C. cryptolepis* Mack., instead of *C. viridula* Michx.
Page 85, line 20, read: Beak more than 0.4 mm. long; instead of 0.4-2 mm.
Page 90, line 6, read: *J. tenuis* Willd.; delete the synonym.
Page 91, line 11 from bottom, read: 5-10 cm. long, instead of 4-10.
Page 117, line 5, read: Panicles.
Page 118, line 10 from bottom, read: Calyx 7-12 mm. long, instead of 10-12.
Page 129, line 18, delete entire line and substitute: 3. Plants not as above.
Page 150, line 15 from bottom, read: *P. argentea* instead of *argenta*.
Page 196, line 8, read: *T. japonica*, instead of *japonicus*.
for genus no. 8, read: *Perideridia* Reichenb. and add the synonym *Eulophus* sensu Nutt., non R. Br. The species name becomes *P. americana* (Nutt.) Reichenb.
Page 197, line 14 from bottom, read: *S. suave* Walt. instead of *S. cicutaefolium* Gmel.
Page 207, line 5, read: 6-10 cm. instead of 6-9.
Page 210, line 20 from bottom, read: 1-2.5 cm. instead of 1.5-2.5
Page 225, line 7 from bottom, read: stamen instead of stamens.
Page 258, line 12, read: arachnoid at first, instead of tomentose.
Page 259, lines 9 and 10 from bottom, read: 1.5-3 m. tall, instead of cm.
Page 266, line 3 from bottom, read: receptacle hairy;
Page 274, definition of berry, read: few- or many-seeded.
Page 279, line 2 of definition of papilionaceous, read: large instead of lalrge.

Big Trees of the Midwest

Kendall Laughlin

The purpose of this article is to summarize the results of my explorations of woodlands in the area enclosed within the following line:—Beginning at Benton Harbor, Mich., thence through Niles, Mich., South Bend, Plymouth, Kokomo and Indianapolis to Jeffersonville, Ind., thence down the Ohio and Mississippi Rivers to the southeast corner of Arkansas, thence west along the southern borders of Arkansas and Oklahoma and north along the western borders of Oklahoma and Kansas and east along the northern borders of Kansas and Missouri to Fort Madison Iowa, thence up the Mississippi River to the northwest corner of Illinois, thence east to Beloit, Wis., thence ENE via the C. M. St. P. & P. Railroad to Racine, Wis.

The list of big trees at the end of this article shows the dimensions and location of the largest individual of each species or hybrid that I have found within this area. Where both the diameter and the circumference are shown, the measurements were taken at 4½ feet above the ground, but where only the diameter is shown it was measured at about 5 feet above the ground or beneath the lowest limb, whichever was less.

Different portions of continuous woodlands, often separated by section line roads, are sometimes known by different names for convenience of reference. In the statistical studies herein each of such aggregated tracts is treated as a unit. A statistical study of such aggregated woodlands yields several interesting results.

91% of the trees in the big tree list occur in colonies and only 9% occur singly, i. e., one in a woodland.

By adding together the diameters of the trees in each aggregated woodland shown in the appended big tree list, such total is a measure of the magnitude of the timber in each of such tracts. The results are shown in the following table:

Rank	Tract	: Total of Diameters	: Total Number of Species and Hybrids	: Ratio Genera/Species
1	Turkey Run	370	51	67%
2	Glenwood, Ark.	321 1/8	43	72%
3	Big Oak Tree State Park, Mo.	299	25	64%
4	Hot Springs, Ark.	227 1/2	49	65%
5	Swope Park	177	56	55%
6	Morton Grove, Ill.	170 1/2	....	....
7	Cox Woods	168 1/2	29	72%
8	Indiana Dunes State Park	121 1/16	62	58%
9	Mountain Fork	112	....	....
10	Chechupinqua	98 1/2	52	48%

The data shown in the last two columns above have no bearing on the method used in rating the various tracts but they are included because they are available for most of the tracts and because of their interest to botanists. It may be noted that the number of species in the first tract in the list, Turkey Run, is nearly the same as in the last tract in the list, Chechupinqua. The highest percentage ratio of genera to species in Turkey Run, 67, attests to a wide diversity of genera, while the low percentage in Chechupinqua, 48, is the result of the remarkable development of the Rosaceae.

All of the above tracts are known more or less to nature lovers of the states where they are located. The acquisition of the publicly owned tracts for public enjoyment has been the culmination of sacrifices or heroic efforts of public spirited citizens, and in the case of privately owned tracts credit should be given to the protection afforded by the owners. A brief description of the tracts and their history are therefore appropriate.

TURKEY RUN

Turkey Run State Park of Indiana, comprising 1520 acres, is located on Sugar Creek in northeastern Parke County 4 miles north of Marshall. Sugar Creek passes here thru a resistant formation of red sandstone, the erosion of which has produced unique scenery. The big trees are scattered, some being in the creek gorge, some on the slopes of side canyons, and others on the uneroded tableland above the gorge.

This tract was homesteaded by Salmon Lusk in 1826. His son, John, a bachelor, jealously guarded his trees from the rapacity of lumbermen. After John Lusk's death in 1915 at the age of 75 it was necessary to divide the property among numerous heirs. In 1916 the 1600 acre Lusk tract was sold at an auction to the Hoosier Veneer Co. for $30,200.

Thru prodigious efforts and publicity Richard Lieber, pioneer conservationist, aided by Mrs. Juliet V. Strauss, procured sufficient state funds to buy the tract for the state. And so, thru the devotion of John Lusk to his trees and the dogged persistence of Mr. Lieber and Mrs. Strauss this foremost tract of timber, the first in Indiana's self-supporting state park system, was preserved from destruction.

GLENWOOD, ARK.

The town of Glenwood, Ark., is located on the Caddo River just above the point where it emerges from the Cossatot Mountains onto the Athens Plateau. All of the big trees of large species in the appended list are in the river valley (which was traversed by Hernando De Soto in 1541); two others are on slopes of Burnham Mt.

I attribute the big trees of Glenwood to the optimum climatic conditions. A ten year precipitation record shows an average annual precipitation of 56.25 inches, which comes very near being the greatest in the Weather Bureau's records in the entire area covered by this survey. The wind movement is light and wind damage is unknown, so that the trees grow to great heights.

Nearly all the big trees of Glenwood are privately owned and the greater part are on ground owned by Robert Franks of Glenwood.

BIG OAK TREE STATE PARK, MO.

This tract of superbly magnificent virgin timber is located in Mississippi County, Missouri, 20 miles south of Charleston and 2 miles north of the Mississippi River. An excursion among these towering trees, limited to relatively few species by long ages of adjustment, is like a trip to a lost world and is a revelation even to a hardened hiker.

The original objective was the purchase of 80 acres belonging to a lumber company for the purpose of saving a big Bur Oak, second in the appended list. The state now owns 1007 acres. It is curious to see these huge Bur Oaks growing on saturated soil under a dense forest canopy so far south.

Credit must be given to Gov. Lloyd C. Stark, Mr. Elgin Davis of East Prairie and other citizens of Mississippi County for their timely efforts in devising ways and means to acquire the original tract. Missourians may well be proud of this magnificent remnant of Mississippi River bottomland timber.

HOT SPRINGS, ARK.

Here are the Hot Springs National Park and the town of Hot Springs. The diverse topography and the protection afforded in this oldest of our national parks have produced a goodly number of outstanding specimens of both mountain and valley types of trees.

MORTON GROVE, ILL.

This tract consists of a strip of timber bordering the North Branch of the Chicago River, extending from Oakton Street to Lake Avenue. It comprises the Miami, St. Paul, Linne, Harms and Glenview Memorial Woods and contains the finest timber in the 35000 acres of the Cook County Forest Preserves.

Four of the five big trees in the appended list belong to large species of wide distribution. The fact that most of them are hydrophytes and the occurrence of many majestic Cottonwoods suggest the presence of a hydrologic factor. I suspect that the factor is the August rainfall, resulting from a thunderstorm center northwest of Chicago. The axis of the 4 inch August isohyet runs thru Morton Grove.

Not much can be said about the past history of this tract except that it once supported an Indian population of five thousand souls.

SWOPE PARK

Swope Park, comprising 1386 acres, is in the southeast corner of Kansas City, Mo. It is the second largest city park in the United States, being exceeded only by Fairmont Park in Philadelphia.

The Blue River, a small stream of ancient geologic history, bordered by a broad high bottom and limestone bluffs 100 feet high, meanders thru the

middle of the park. Before the glacial period the present channel of the Missouri River below Kansas City was the channel of the Kansas River; and after the retreat of the ice sheet the Missouri River was displaced to its present location and the channel of the big river and the channels of its tributaries were deepened considerably, so that the channel of the Blue River is now deeply entrenched in its ancient high bottom. Oddly enough, the high bottom is the only part of the park that is mostly treeless.

The varied topography and rich limestone soil of the bluffs and uplands have encouraged the growth of many species, aided by a high percentage of sunshine. This park boasts 8 champions in the American Forestry Assn.'s list (one of which is just outside the park). In this park, where the Ozark and northern floras overlap, there are 10 species of Oaks, 3 hybrid Oaks, 5 species of Hickories and 3 species of Elms. This total of 21 species and hybrids of the three dominant genera of the region is greater than in any other woodland.

The bulk of Swope Park was a gift of 1354 acres from Thomas H. Swope, who is honored by his mausoleum. Later 8 acres were cut out of the park by the "high line" of the K. C. S. Railway. A few years ago 40 acres were added by purchase.

COX WOODS

Cox Woods, comprising 200 acres, is located 2 miles southeast of Paoli, Ind., between U. S. Highway 150 and Indiana Highway 37. The northern part is bottomland bordering on Lick Creek and contains the finest specimens of Black Maple in America. The southern part is mostly hilly with the exception of a portion in a small tributary valley. The hill soil is a red clay, which is deeply eroded in the absence of trees. In the southern part there are large specimens of White Oak, Northern Red Oak, Tuliptree, Black Walnut, White Ash, Beech and Flowering Dogwood. Photographs show the most intense competition, with closely spaced spindling saplings shooting upward to the light.

There seems to be nothing particularly favorable about the soil or the climate to produce such a dense growth of large trees, so that credit must be given to the Cox family and, latterly, the U. S. Forest Service for the excellent state of preservation of this tract.

The south 150 acres was purchased in 1942 from the Wood-Mosaic Co. for $24,150, which was raised by public subscription through the efforts of the Paoli Meridian Club and the Pioneer Mothers of Indiana Society, aided by the American Forestry Assn's publicity. The north 50 acres, known as the Jeff Cox tract, bordering on Lick Creek, was purchased about two years ago for $1800, half of which was raised by public subscription thru the efforts of the Paoli Meridian Club and the other half appropriated by the U. S. Forest Service.

Cox Woods is now embodied in the Hoosier National Forest.

INDIANA DUNES

The Indiana Dunes State Park, comprising 2221 acres, is located at Tremont, Porter County, Indiana, between Lake Michigan and the Chicago South Shore & South Bend Railroad. It is exactly three miles wide from east to west and has a frontage of 3.3 miles on the lake. High moving sand dunes border the lake and reach a maximum height of 196 feet above the lake. The sterile sand hills support a growth of Black Oak, Witch-Hazel, Sassafras and Chokecherry, with Smooth Basswood on the summits of the dunes. The lowlands south of the dunes present a bewildering display of fifty-odd species of trees. The total number of species, 62, is greater than in any other woodland of similar size and includes boreal relicts and southern invaders.

The trees are not conspicuously large. The largest is an American Elm 35 inches in diameter. White Oaks, Black Oaks, Northern Red Oaks, Pin Oaks, White Pines, Tuliptrees, Black Gums, Red Maples and Beeches exceed 2 feet in diameter.

The outstanding dendrological fact is that all the small species of trees attain phenomenal size in this particular tract. In the Warren Dunes State Park of Michigan, a tract of similar aspect, only two species attain a larger size than in the Indiana Dunes.

MOUNTAIN FORK

The rank of this tract is the result of the occurrence of a gigantic Baldcypress, the largest and oldest tree in the entire area covered by this survey. This tree is located half a mile west of Mountain Fork River, half a mile north of U. S. Highway 70 and 2 miles west of Eagletown, McCurtain County, Oklahoma. It is on ground that was once the seat of government of the Choctaw Nation.

The existence of this remarkable tree, growing on relatively dry ground at the northwestern limit of the range of the species, proves the dendrologists' contention that the Baldcypress makes its best growth on dry land; it grows in water only to escape the competition of other species. Evidently the Baldcypress gained a foothold in this locality at an early age and thrived in the absence of much competition. There are other Baldcypresses 5 feet in diameter and there are of course other species of trees in the surrounding woods but the number is not large.

This tract is now privately owned, the former mansion of the Choctaw Nation's native governor serving as the owner's residence.

CHECHUPINQUA

The Chechupinqua tract extends along the Des Plaines River from Belmont Avenue to Devon Avenue and includes interesting types of woods spreading over the level drift plain for nearly a mile east of the river. It includes the Chechupinqua Woods, Schiller Woods and Robinsons Woods of the Cook County Forest Preserves.

With a representation of 52 species, Chechupinqua presents an excellent cross section of the flora of the Chicago region. The Rosaceae are found

in great variety and numbers. The Hawthorn forests, composed of the species *mollis, punctata, crus-galli, disperma, sertata, calpodendron* and *succulenta (gemmosa),* reach their greatest development here. The shrubby Hawthorns grow in dense thickets, the medium trees form dark canopies with interwoven branches, and the large species grow in open fashion. The variable *Quercus ellipsoidalis,* appearing in 4 forms, is very common. The Ashes are very numerous and the Green and White Ashes reach a large size. The Green Ash in the appended list, on the north bank of the Des Plaines River in Robinsons Woods, which has a diameter of 3 feet 5 inches, a circumference of 12 feet, a spread of 71 feet and a height of 54 feet, is the largest in the Mississippi Valley. Part of the Chechupinqua Woods is of the nature of a park forest, composed of Oaks, Elms, Ashes and some Red and Silver Maples.

Chechupinqua includes half a section given to Claude La Framboise and two sections of land given to Chief Chechupinqua of the Potawatomi, Ottawa and Chippewa Nations in a treaty made by the Federal government with those nations in 1833. This gift to Chief Chechupinqua, whose English name was Alexander Robinson, was a reward for the aid he gave to survivors of the Fort Dearborn Massacre. Chief Chechupinqua died in 1872 at the age of 110 years and is buried in the Robinson family cemetery in Robinsons Woods. His descendants still live in Robinsons Woods.

SUMMARY

1. In a dendrological survey listing the largest individual of each species of forest tree in an area equivalent to five or six states, the trees are found to be widely scattered but they have a strong tendency to be concentrated in groups scattered thruout the area. 91% are found in groups.

2. By treating each continuous tract of woodland as a unit and adding the diameters of the trees in the list described above found in each of such tracts, such total is a measure of the magnitude of the timber found therein. The highest ranking woodlands are well known to nature lovers in the region roundabout. In two instances factors of rainfall, which is the most important influence in the growth of trees, are indicated.

3. A brief history of the ten highest ranging woodlands is given,—as a tribute to the generosity or perseverance of public spirited citizens who have made these tracts available for public enjoyment, and to private owners for their preservation—and as a stimulus to efforts to preserve other outstanding tracts of specimens of America's vanishing timber.

LIST OF BIG TREES

SPECIES	DIAMETER	CIRCUMFERENCE	LOCATION
Taxodium distichum	9'4"	29'3"	Mountain Fork Valley, McCurtain Co., Oklahoma
**Quercus macrocarpa*	6'5"	21'1"	Big Oak Tree State Park, Missouri
Ulmus americana	5'10"		Com. Barry Country Club, Twin Lakes, Wisconsin
Platanus occidentalis	4'9½"		Turkey Run State Park, Indiana
Quercus alba	4'6½"		Turkey Run State Park, Indiana
Populus deltoides	4'4½"	13'	Miamis Woods, Cook Co., Illinois
Gleditsia triancanthos	4'4"	13'3"	Loose Park, Kansas City, Missouri
Liriodendron tulipifera	4'½"		Turkey Run State Park, Indiana
**Carya laciniosa*	3'11"	12'7"	Big Oak Tree State Park, Missouri
Quercus borealis	3'11"		Warren Woods, Three Oaks, Michigan
Quercus palustris	3'11"	12'2"	Big Oak Tree State Park, Missouri
Quercus prinus	3'11"		Big Oak Tree State Park, Missouri
Quercus shumardi	3'10½"	12'5"	Glenwood, Arkansas
**Quercus falcata pagodaefolia*	3'3"	10'7"	Big Oak Tree State Park, Missouri
Acer saccharinum	3'10"	11'5"	Linne Woods, Cook Co., Illinois
Fraxinus americana	3'10"		Cox Woods, Paoli, Indiana
Juglans nigra	3'9"		Turkey Run State Park, Indiana
Celtis occidentalis	3'8"	11'6"	Brush Creek at Holly St., Kansas City, Missouri
Acer saccharophorum	3'8"		Warren Woods, Three Oaks, Michigan
Tilia americana	3'8"	10'2"	Black Partridge Woods, Cook Co., Ill.
Ulmus thomasi	3'6"		Big Oak Tree State Park, Missouri
Liquidambar styraciflua	3'6"		Glenwood, Arkansas
Fraxinus pennsylvanica lanceolata	3'5"	12'	Robinsons Woods, Cook Co., Illinois
Pinus strobus	3'4"		White Pines State Park, Illinois
Quercus bicolor	3'4"		Harms Woods, Cook Co., Illinois
Quercus muehlenbergii	3'4"		Cox Woods, Paoli, Indiana
Fagus grandifolia	3'3½"		Cox Woods, Paoli, Indiana
**Quercus ellipsoidalis*	3'3"	10'	Dunes Park, Illinois
Ulmus fulva	3'3"	10'7"	Funks Grove, Illinois
Quercus velutina	3'2"		Van Meter State Park, Missouri
Prunus serotina	3'1"		Turkey Run State Park, Indiana
Fraxinus quadrangulata	2'11"	8'9"	Funks Grove, Illinois
Quercus phellos	2'10"		Near Spring St., Hot Springs, Arkansas
Acer nigrum	*2'10"	9'1"	Turkey Run State Park, Indiana
	2'10"	9'1"	Cox Woods, Paoli, Indiana
Quercus nigra	2'8½"		Glenwood, Arkansas
Quercus imbricaria	2'7"		Loose Park, Kansas City, Missouri
Quercus stellata	2'7"	8'	Hot Springs National Park, Arkansas
Ulmus alata	2'7"		Glenwood, Arkansas
Betula nigra	2'6½"		Glenwood, Arkansas
Pinus taeda	2'6"		Glenwood, Arkansas
Pinus echinata	2'6"		North Mt., Hot Springs, Arkansas
Carya ovata	2'5½"		Turkey Run State Park, Indiana
Celtis laevigata	2'5½"	8'1"	Army & Navy Gen. Hospital, Hot Springs, Arkansas

* Recognized by the American Forestry Assn. as the largest of its kind in the U.S.

LIST OF BIG TREES—(Continued)

SPECIES	DIAMETER	CIRCUMFERENCE	LOCATION
**Quercus runcinata*	2'5½"	8'8"	Heathwood Park, Kansas City, Kansas
**Tilia caroliniana rhoophila*	2'5"	7'1"	Glenwood, Arkansas
Nyssa sylvatica	2'5"		Fountain St., Hot Springs, Arkansas
Tsuga canadensis	2'4"		Turkey Run State Park, Indiana
**Tilia palmeri*	2'4"	7'4"	Scarritt Point, Kansas City, Missouri
Acer rubrum	2'2"		Dunes State Park, Indiana
**Quercus bebbiana*	2'1"	6'8"	Swope Park, Kansas City, Missouri
Acer negundo	2'1"	6'7"	Linne Woods, Cook Co., Illinois
Carya cordiformis	2'	6'3"	Swope Park, Kansas City, Missouri
Morus rubra	2'	6'2"	Swope Park, Kansas City, Missouri
**Ulmus serotina*	1'11"	5'11"	Glenwood, Arkansas
Juniperus virginiana	1'10"	5'5"	Glenwood, Arkansas
Juglans cinerea	1'10"	5'10"	Chechupinqua Woods, Cook Co., Illinois
Fraxinus nigra	1'9½"		Billy Caldwell's Reserve, Chicago, Illinois
Maclura pomifera	1'9"		Swope Park, Kansas City, Missouri
Gymnocladus dioicus	1'9"		Parkwood Park, Kansas City, Kansas
**Quercus bushii*	1'8"	5'1"	South of Swope Park, Kansas City, Mo.
**Crataegus mollis*	1'8"	6'1"	Morton Arboretum, Lisle, Illinois
Diospyros virginiana	1'8"		Swope Park, Kansas City, Missouri
Quercus marilandica	1'7½"		South of Swope Park, Kansas City, Mo.
**Carya texana arkansana*	1'7"	5'1"	Hot Springs National Park, Arkansas
**Populus tacamahaca candicans*	1'7"	4'9"	Dunes Park, Illinois
**Crataegus punctata*	1'6"	4'10"	Billy Caldwell's Reserve, Chicago, Illinois
Aesculus glabra	1'6"		Turkey Run State Park, Indiana
Carya tomentosa	1'5"		Albert Pike Camp, Ouachita Nat. Forest, Arkansas
Ostrya virginiana	1'4"	4'2"	Palos Park Woods, Cook Co., Illinois
Castanea dentata	1'4"		Dunes State Park, Indiana
Carya glabra	1'2"		Turkey Run State Park, Indiana
Castanea ozarkensis	1'2"	3'5"	Hot Springs National Park, Arkansas
Sassafras albidum	1'2"		Van Meter State Park, Missouri
Cercis canadensis	1'	3'3"	North Terrace Park, Kansas City, Mo.
Carpinus caroliniana	11½"		Glenwood, Arkansas
**Salix longipes wardi*	11"	2'11"	Glenwood, Arkansas
**Populus grandidentata*	10"	2'11"	Dunes State Park, Indiana
Populus tremuloides	9½"		Dunes State Park, Indiana
**Malus ioensis*	9"		Swope Park, Kansas City, Missouri
Amelanchier arborea	9"		Dunes State Park, Indiana
Cornus florida	9"		Cox Woods, Paoli, Indiana
	9"		West Mt., Hot Springs, Arkansas
Magnolia tripetala	8"		Hot Springs National Park, Arkansas
**Crataegus crus-galli*	8"	2'	Chechupinqua Woods, Cook Co., Illinois
**Rhamnus cathartica*	8"	2'6"	Schiller Woods, Cook Co., Illinois
Bumelia lanuginosa	8"		Hot Springs National Park, Arkansas
**Prunus americana*	7½"		Saline River, Ouachita Nat. Forest, Ark.
Asimina triloba	7"	1'11"	Hot Springs National Park, Arkansas
**Craetaegus sertata*	7"	2'4"	Glenview Memorial Woods, Cook Co., Ill.

* Recognized by the American Forestry Assn. as the largest of its kind in the U.S.

LIST OF BIG TREES—(Continued)

SPECIES	DIAMETER	CIRCUMFERENCE	LOCATION
Prunus pensylvanica	7"	1'10"	Chechupinqua Woods, Cook Co., Illinois
Robinia pseudoacacia	7"		Eagle Mt., Polk Co., Arkansas
	7"		Burnham Mt., Glenwood, Arkansas
Malus soulardi	6"		Dunes State Park, Indiana
**Crataegus arduennae*	6"	1'9"	Swope Park, Kansas City, Missouri
**Crataegus disperma*	6"	2'4"	Schiller Woods, Cook Co., Illinois
**Crataegus calpodendron*	6"	1'11"	Morton Arboretum, Lisle, Illinois
**Rhus typhina*	6"	1'10"	Dunes State Park, Indiana
Ilex opaca	6"		Ouachita National Forest, Arkansas
**Cephalanthus occidentalis*	6"	1'6"	South of Lisle, Illinois
**Viburnum lentago*	6"	1'7"	Dunes State Park, Indiana
**Viburnum rufidulum*	6"	1'4"	Bennett Spring State Park, Dallas Co., Missouri
**Alnus incana*	5"	1'4"	Dunes State Park, Indiana
**Prunus lanata*	5"		Bard Spring, Ouachita Nat. Forest, Ark.
Rhus vernix	5"		Dunes State Park, Indiana
Salix interior	4½"		Dunes State Park, Indiana
**Hamamelis virginiana*	4"	1'2"	Dunes State Park, Indiana
Crataegus succulenta	4"		River Grove, Illinois
	4"		Chechupinqua Woods, Cook Co., Illinois
Prunus virginiana	4"		Dunes Park, Illinois
Ptelea trifoliata	4"		Warren Dunes State Park, Michigan
**Euonymus atropurpureus*	4"	1'	Turkey Run State Park, Indiana
**Acer leucoderme*	3½"		Little Brushy Creek, Ouachita Nat. Forest, Arkansas
**Cornus alternifolia*	3½"	1'	Black Partridge Woods, Cook Co., Illinois
**Juniperus communis*	3"	9"	Dunes State Park, Indiana
Alnus rugosa	3"		Hot Springs National Park, Arkansas
**Quercus prinoides*	3"	10"	Swope Park, Kansas City, Missouri
Celtis pumila georgiana	3"		Hot Springs National Park, Arkansas
Malus coronaria	3"		Dunes State Park, Indiana
Crataegus delecta	3"		Dunes State Park, Indiana
Rhus copallina	3"		Dunes State Park, Indiana
**Cornus drummondi*	3"	11"	Swope Park, Kansas City, Missouri
Vaccinium arboreum	3"		Burnham Mt., Glenwood, Arkansas
	3"		West Mt., Hot Springs, Arkansas
Rhus glabra	2½"		Chechupinqua Woods, Cook Co., Illinois
**Viburnum prunifolium*	2½"	9"	Swope Park, Kansas City, Missouri
Crataegus marshallii	2⅛"		Glenwood, Arkansas
Zanthoxylum americanum	*2 1/16"	7"	Pawpaw Woods, Cook Co., Illinois
	2 1/16"		Dunes State Park, Indiana

* Recognized by the American Forestry Assn. as the largest of its kind in the U.S.

Observations on Bryophytes Living in an Artificially Illuminated Limestone Cave

Edward P. Thatcher

Following a report that bryophytes had been found growing on the limestone walls of Niagara Cave, near Harmony, Fillmore County, Minnesota, the locality was visited on November 26, 1939. Observations and measurements were made on that day and on two subsequent visits, June 24, 1942 and July 6, 1946. The results are presented in this paper, together with a brief survey of the scattered work of similar nature done elsewhere.

Previous Observations on Bryophytes Growing in Illuminated Caves

Examination of published reports of bryophyte growth in illuminated caves has revealed that many species have been found in this habitat. Bryophytes have been reported from several widely scattered illuminated caves in Europe. Lundegårdh (1931) has reported algae, certain ferns, and mosses in the light range of incandescent lamps in caves at Macocha, Czechoslovakia. Maheu and Guerin (1935) have identified nine species of bryophytes in illuminated caverns of France and Belgium. Several accounts of bryophytes growing in illuminated caves in the United States have appeared. Maheu (1926) has reported seven species from several caves. including the well known Mammoth Cave, in the limestone region of Kentucky. The bryophytes which have been reported from illuminated caves of Europe, Kentucky, New York (1931), and Virginia (1943) are listed in the table. The species collected and identified from Niagara Cave, Minnesota, the subject of the present study, are also included.

Of the 26 species listed in the table 21 occur in one locality, three in two localities, one in three and one in four. Those found in two or more cave locations are among the most common and widespread of all bryophytes. There is no indication that any particular species is peculiarly adapted to such conditions as the cave environment offers.

Niagara Cave as an Environment for Bryophytes

Niagara Cave, in southeastern Minnesota, was discovered in 1924. Artificial lighting was installed and the cave opened as a commercial enterprise in 1934.

The limestone rock in which water has dissolved the subterranean passages is of Ordovician age. The Maquoketa formation of the Cincinnatian series, the uppermost in this region, is 85-100 feet thick; below this the Galena formation (Stewartville and Prosser members) of the Mohawkian series has a thickness of 175-180 feet (Stauffer & Thiel, 1941.) Since the deepest

SPECIES (9)	LOCALITIES				
	France-Belgium, Maheu & Guerin (1935)	Kentucky Caves, Maheu (1926)	Luray, Virginia, Lang (1943)	Howe Caverns, N. Y. Haring (1931)	Niagara Cave, Minn.
Amblystegium Juratzkanum Schimp.				×	
Amblystegium serpens (Hedw.) Br. & Sch.	×				
Amblystegium varium (Hedw.) Kindb.					×
Amphidium Mougeottii (Bry.) Schimp.				×	
Anomodon attenuatus (Hedw.) Hueben		×			
Anomodon rostratus (Hedw.) Schimp.		×			
Barbula unguiculata Hedw.					×
Brachythecium rivulare Br. & Sch.		×			
Brachythecium rutabulum Br. & Sch.				×	
Bryum capillare Hedw.				×	×
Bryum caespiticium L.				×	
Bryum bimum Schreb.			×		
Campylium chrysophyllum (Brid.) Bryhn					×
Ceratodon purpureus (Hedw.) Brid.			×		×
Cratoneuron commutatum (Hedw.) Roth	×				
Eurynchium praelongum (L.) Bryhn	×	×			
Eurynchium rusciforme (Necke) Milde	×				
Eurynchium serrulatum (Hedw.) Kindb.			×		×
Fissidens taxifolius Hedw.	×				
Funaria hygrometrica Hedw.	×			×	×
Gymnostomum calcareum Nees & Hornsch.		×			
Leptobryum pyriforme (L.) Schimp.			×	×	
Mnium rostratum Schrad.		×			
Polytrichum sp.	×				
Thuidium sp.			×		
Weisia viridula Hedw.			×		
Marchantia polymorpha L.	×	×		×	×

level of the cave is 260 feet below the ground surface it is assumed that the cave passages are entirely within these formations.

In 1939 the manager of Niagara Cave informed the writer that at that time bulbs in the cave were burning about 10-12 hours daily during the summer tourist season. During the colder months of the year the bulbs burned only occasionally for short periods.

The atmospheric moisture of the cave is high. Wet and dry bulb temperatures were obtained by the use of a sling psychrometer at 200 feet below the ground surface. From these readings the following figures were calculated (Marvin, 1915):

Dew point—49 degrees F.
Vapor pressure deficit—0.660 mm. of mercury.
Relative humidity—94%.

BRYOPHYTES IN NIAGARA CAVE

The nearly circular bryophytes colonies surrounding the electric bulbs were found to be dominated by the cord moss, *Funaria hygrometrica*. The prenomenon of phototropism was very apparent in the leafy plants of this species. The angle of inclination from the vertical in the stem was observed to increase with distance from the bulb.

Zonation marked by differentiation in growth stage was very evident and regular in the colonies of Funaria. A zone of dried and brown capsules surrounded the bulb of many colonies. Outside this were concentric zones of leafy stems and protonemata. The distance of the farthest capsule from a 50-watt bulb lighting a particularly large colony was found to be 25 centimeters. The greatest measured distance from the light source to leafy stems in this colony was 60 centimeters. Visible protonemata ranged to a distance of 110 centimeters from the bulb.

The writer returned to the cave on July 6, 1946, for the purpose of noting the effect of reduced illumination as a result of the greatly reduced traffic to the cave during the war years. It was found that the colonies had diminished in size. The colonies on which measurements had been taken in November 1939 had disappeared entirely due to change in the positions of the light bulbs, but new ones of reduced size had appeared in new locations. On this visit the distance of the farthest visible protonemata from a 60-watt bulb illuminating a particular colony was found to be only 45 centimeters. Two species present in 1942, *Barbula unguiculata* and *Campylium chrysophyllum* had disappeared. No additional ones had appeared.

Two reports (Haring, 1931, Lang, 1941) of plant growth in caverns have offered the conjecture that water is the only agency responsible for the introduction of spores into a subterranean situation where conditions favor germination. The writer believes that air currents may be a plausible agency for the transportation of moss spores into this cave.

A mature frond of the spiny shield fern, *Dryopteris spinulosa* (O. F. Muller) Watt. was collected in the cave in 1942. This plant had disappeared in 1946, though fern prothallia remained in evidence.

Modifications Under Cave Conditions

Close examination of some of the mosses collected in Niagara Cave has revealed that these differ morphologically in several respects from plants of the same species growing in normal terrestrial environments. The modifications observed are noted below.

Funaria hygrometrica.—Longer internodes, increased length of leaf, decreased width of leaf, reduced strength of nerve.

Ceratodon purpureus.—Longer internodes than in specimens collected in xeric environments, not decidedly cespitose.

Campylium chrysophyllum.—Reduced leaf size, greatly reduced strength of nerve.

Eurynchium serrulatum. — Leaf plication absent, decided reduction in strength of nerve.

As to reproductive activity, only two mosses, Funaria and Bryum, were collected in the fertile state. In the other five, which normally bear capsules freely, none were found. The liverwort, Marchantia, was not observed to bear gametangia, but gemmae were noted on some plants.

It appears that moss plants of several species found growing in Niagara Cave differ chiefly from plants of the same species found in terrestrial environments in modification of the foliar organ and in capacity to produce capsules.

REFERENCES

GROUT, A. J. 1928-39—Moss Flora of North America, North of Mexico. Newfane, Vt.

HARING, I. M. 1931—Plant Growth under Electric Lights. Bryologist **33**:89-91.

LANG, W. B. 1941—Mosses in Virginia Caverns. Science **94**:414.

———1943—The Mosses of Luray Cavern, Virginia. Science **98**:173-174.

LUNDEGÅRDH, C. 1931—Environment and Plant Development. Translated by Eric Ashby. London.

MAHEU, J. 1926—La flore cavernicole americaine. Bull. Soc. Bot. France **73**:39-57.

———, AND H. P. GUERIN. 1935—Influence de la lumière electrique sur la flore cavernicole. Bull. Soc. Bot. France **82**:477-494.

MARVIN, C. 1915—Psychrometric Tables for Obtaining the Vapor Pressure, Relative Humidity, and Temperature of the Dew Point. Washington, D. C.

STAUFFER, C. R. AND G. THIEL. 1941—Paleozoic and Related Rocks of Southeastern Minnesota. Minn. Geol. Surv. Bull. **29**.

Acknowledgment

The writer wishes to express his appreciation to Dr. W. S. Cooper, Dr. D. B. Lawrence, and Dr. C. O. Rosendahl of the Department of Botany, University of Minnesota for their kind advice during the preparation of this paper. Thanks are also due Dr. W. C. Steere of the Department of Botany, University of Michigan for his help in the identification of the Niagara Cave bryophytes.

BLACK HILLS TEACHERS COLLEGE,
SPEARFISH, SOUTH DAKOTA.

Euphorbia intercedens Podp., a Homonym

Leon Croizat

In a paper previously published in these pages (Amer. Midl. Nat. 33: 231. 1945), I dealt with *Euphorbia Esula* L. and the forms of its affinity in North America. In full knowledge of the unsettled status of the nomenclature of this complex, I accepted at least as temporarily useful the binomial, *Euphorbia intercedens* Podp. in Publ. Fac. Sc. Univ. Masaryk **12**:29. 1922. This binomial, exemplified by authentic specimens in the herbarium of the Arnold Arboretum of Harvard University, properly belongs to a form which has become fairly common in North America.

My former colleague and good friend, E. J. Palmer, has informed me that *E. intercedens* Podp. is a later homonym of *E. intercedens* Pax in Engl. Jahrb. **34**:75. 1905, which latter is validly published. Accordingly, Podpera's name has no status in legitimate nomenclature.

This circumstance is much to be regretted, for it places me before unwelcome alternatives. Long years may elapse before it proves feasible even to begin the work of basic revision necessary to put the classification of *E. Esula* L. and its vast alliance on a sound taxonomic and nomenclatural footing. During this time, it is altogether likely that the majority of classifying botanists will feel strong repugnance against accepting, and using, a name which is tainted by notorious illegitimacy. It is probable, on the other hand, that a final reckoning will show that Podpera's entity, his *E. intercedens,* is synonymous with some obscure species published long ago by Schur, or another local taxonomist.

Weighing these alternatives, and considering that hardly anything can be authoritatively done on these forms in the near future; taking into account the extreme difficulty of locating original types and isotypes, and the doubts necessarily attending the interpretation of brief and obscure descriptions contributed by Silesian, Austrian, Transsylvanian, Hungarian authors, etc.; it seems now to me that the lesser evil consists in substituting for Podpera's binomial a new one which should be free from patent illegitimacy. This name may be used for reference by American taxonomists, and other botanists, with the immediate assurance that it can be connected to specimens deposited in a well known herbarium of the United States. If this name should later on fall under a stringent revision of the "*Esula* complex" throughout the world, it still will have served its immediate purpose. Accordingly, I propose:

Euphorbia Podperae Croiz. nom. nov.

E. intercedens Podp. in Publ. Fac. Sc. Univ. Masaryk **12**:29. 1922; Domin, Pl. Cecosl. En. 77. 1935 — *non E. intercedens* Pax in Engl. Bot. Jahrb. **34**:75. 1905.

Elsewhere I have dealt with forms of the "*Esula* complex" in a publication (Jour. Japanese Bot. 17:573. 1941) which I have only recently seen, thanks to my good friend Dr. H. Hara of Tokyo Imperial University, Tokyo, Japan. In this paper (October 1941), I refer to *E. virgata* Wald. & Kit. (in op. cit. 575) as illegitimate. This conclusion was later modified in the paper published in these pages (January 1945), as it may not be necessary to reject this binomial entirely.

MINISTERIO DE AGRICULTURA Y CRIA,
CARACAS, D. F., VENEZUELA.

Book Reviews

THE STRUCTURE AND REPRODUCTION OF THE ALGAE. Volume II. Foreword, Phaeophyceae, Rhodophyceae, Myxophyceae. By F. E. Fritsch. University Press, Cambridge; The Macmillan Company, New York, 1945. 939 pp., frontispiece, 336 textfigs., 2 maps. $12.00.

This second volume concludes Professor Fritsch's excellent and ambitious general review of literature on the algae. The foreword consists of short discussions of the ecology and distribution of marine algae. Both are profusely sprinkled with references to a long bibliography of papers and books on the subjects. Both necessarily suffer from the scarcity of such more or less reliable data as are available to students of the vascular plants in monographs of genera and families; here the data are derived principally from descriptions of local floras by workers intimately acquainted at best with regional floras. A similar lament might be made of the treatments of the Phaeophyceae, Rhodophyceae and Myxophyceae which comprise the bulk of the work. Writing and publishing during the recent War, the author — as he points out in the preface — was unable to consult numerous papers in non-British journals.

Discussions of the brown, red, and blue-green algae follow the general method employed in Volume I. The classes and orders, and also a number of families and genera of special interest, are separately and rather fully treated in respect to morphology, cytology, reproduction, distribution, ecology, and biology. Most structures and many of the species mentioned are illustrated by drawings or photographs which unfortunately have suffered by being printed on paper of poor quality. In the Myxophyceae are included many unlawful names of genera and species published without Latin descriptions since January 1, 1935.

The two volumes review such an enormous amount of literature that their permanent usefulness to students of the algae is unquestionable. — FRANCIS DROUET, Chicago Natural History Museum.

TRACE ELEMENTS IN PLANTS AND ANIMALS. By Walter Stiles. Cambridge: at the University Press; New York. Macmillan, 1946. Pp. xi+189. 12 plates. $2.75.

It was discovered in the last century that some elements were essential in trace amounts for normal development of organisms in addition to the major elements and iron. The research on trace elements started slowly but in recent years has snowballed into an avalanche of hundreds of separate publications. Stiles has done an excellent job in concentrating the salient facts from the vast, and occasionally vaporous, literature.

The book has six chapters, respectively concerned with the following topics: historical introduction, methods of research, deficiency diseases of plants, functions of trace elements in plants, trace elements in animals, and conclusions. There is also a good bibliography and an index.

The discussion of methods in micronutrient research is quite detailed, giving a clear account of culture techniques, quantitative analytical methods sensitive to micrograms, and diagnostic features of deficiencies in plants. This is followed by descriptions of plant diseases induced by mineral deficiencies: — grey speck of oats, speckled yellows of sugar beet, marsh spot of peas, and others due to lack of manganese; pecan rosette, little leaf of fruit trees, frenching of citrus, and others due to insufficient zinc; and several diseases caused by lack of boron and copper.

In the chapter on the functions of the micro-elements there is a good discussion of the inter-relationship of iron and manganese. Reference is made to information on the specific activity of the elements in the plant. Although much has been written on deficiencies in many plants, relatively little is known of the physiological functions of these elements. Some of the more pertinent information concerning the relation of trace elements to enzyme activity is discussed, but space was not given to an extensive review of the biochemical contributions on this phase.

The briefer section on animals seems indicative of the greater interest in mineral nutrition displayed by botanists as compared to zoologists. As in plants most work has been done on those micro-nutrients whose deficiency, or excess, results in definite pathological symptoms, e.g., selenium, molybdenum, copper, iodine, manganese, and cobalt.

The book contains a surprising amount of information in a small package and will be of great service to anyone interested in the pathology or physiology of inorganic nutrition. While it can scarcely be criticized for its contents several improvements might be suggested. For one thing, there is an ambiguity regarding the essential character of several of the elements, e.g., gallium, tungsten, aluminum, and others; the reader would prefer a simple statement of criteria for considering a specific element as essential. In another case, although devoting considerable space to methods of culture, purification of solutions, etc., the subject of vessels is dismissed with a sentence about the suitability of pyrex; this, of course, depends upon the nature of the problem investigated, other materials having been used with success as, for example, in studies of silicon nutrition.

Compared to the valuable principles given in the monograph the suggestions above are of small matter — indeed, the brevity of the book is one of its virtues. It is of greatest importance that this summary of the literature on micro-nutrients has been made — and done so well. — NOE HIGINBOTHAM.

LABORATORY EXERCISES, BIOLOGY OF PLANTS. By H. L. Dean. Wm. C. Brown Company, Dubuque, Iowa. 2nd ed. 1944. 244 pp. incl. 52 pp. of figures. (Planographed; unbound).

Teachers looking for a laboratory manual in botany will find in Dean's exercises an excellent survey of the field. Containing 47 exercises plus numerous addenda and inserta, it ranges from exercises on the plant, the cell, etc., to landscaping and economic plant geography. It is apparently designed for a two-semester course with a weekly laboratory or a course of one semester having two periods of laboratory a week.

The early exercises are devoted to the plant as a whole, leaf modifications, the microscope, the cell, and leaf structure. These are followed by experiments on photosynthesis, respiration, and transpiration, preceding study of stem and root structure. Exercises on cell division, osmosis, growth movements, growth substances, and reproduction of flowering plants complete the introduction of the student to the general morphology and physiology of seed plants.

Exercises 27-42 are devoted to an evolutionary survey of the plant kingdom in the order: algae, bacteria, fungi, mosses, ferns, horsetails, club mosses, and "the pine." The remaining work is concerned with drug plants, economic plant geography, classification, ecology, landscaping, and genetics.

Directions for the student are quite complete and should allow independent work. Each "exercise" starts with an introduction, includes several separate exercises, and ends with a list of references and a set of questions. The drawings for labelling by the student, which accompany the work of morphology, are well-done and, on the whole, are quite accurate representations, adequately supplementing the student's observations.

Provision for field work is made by the inclusion of keys to common trees, gymnosperms, and ferns. Although intended for plants in the vicinity of Iowa, the keys include a sufficient number of genera so that they should prove applicable in many parts of the country.

The manual is also enhanced by the presence of keys to starch grains of different plants and to the various common woods.

The laboratory directions are clearly written and present an excellent set of experiments. Although it seems remarkably free of errors, it has repeated a classic in referring to the "spireme thread" (of the onion) which "breaks up into 16 chromosomes."

On the whole the manual achieves a good balance between the various portions of the course, e.g., morphology, physiology, taxonomy, etc. However, many teachers may be disappointed with the omission of *Spirogyra* in dealing with the algae. *Spirogyra* is as much in the tradition of a botany course as *Marchantia* — which was also omitted along with all other liverworts. Since an important function — probably the most important function — of a survey of the plant kingdom is the conveyance of some concept of evolution to the student, this reviewer thinks the omission of *Spirogyra* and *Marchantia* is justified because these plants do not fit well in the main evolutionary lines. From this standpoint, however, the presentation of *Protococcus* as a primitive green alga is unfortunate, since, as modern concepts would have it, *Chlamydomonas*, a motile green unicell, is the probable prototype of the Chlorophyceae. Neither are the mosses the best evolutionary type of the Bryophyta.

In justification of the author's choice of types — as in other exercises — he has rather consistently presented material well designed to acquaint the student with the forms around him in everyday life and with the practical application of plant science. Thus Dean's laboratory outline will undoubtedly enjoy a successful tenure in many schools. — NOE HIGINBOTHAM.

FLORA DE CUBA. Por el Hermano León (Joseph S. Sauget y Barbier). Contribuciones Ocasionales del Museo de Historia Natural del Colegio de La Salle, No. 8, Cultural, S. A., Habana, Cuba, 1946. Vol. 1, Gimnospermas, Monocotiledoneas; 441 pp., 158 figs., frontispiece, 2 maps. $7.50.

The flora of Cuba, like that of many natural and political areas in the Americas, has long lacked a modern comprehensive treatment. Therefore, the appearance of the first volume of the *Flora de Cuba* will be welcomed not only by students of the Cuban flora but also by all those interested in the Antillean area in general. Though many distinguished botanists had visited Cuba and collected extensively in various parts of the island, none had ever acquired the intimate knowledge of its flora which the author gained in a long and fruitful lifetime of study. In addition, he enlisted the cooperation of specialists, both in Cuba and elsewhere, to assist in the preparation of the treatment of their respective groups or to prepare these parts themselves. Thus the new *Flora* represents the best available knowledge of the plants native in Cuba. The numerous drawings and photographs are on the whole well reproduced and readily convey the varied and rich character of the Cuban flora. That the botanical exploration of Cuba has not yet been completed is attested by the fact that various new species are described in this volume (see the list of new species and new names on page 407). Information concerning early botanical collectors and their work on the island is found in the general introduction which contains also a glossary of technical terms and a brief review of the phytogeography of the island. The descriptions and keys are concise and adequate. Synonyms, vernacular names, and geographic distribution are always given and often supplemented by other interesting data or critical notes. A bibliography of the more important sources and a detailed index of scientific names conclude the book. The fly-leaves are decorated with sketches of distinctive vegetation types and a map of their distribution. The author is to be congratulated on the excellence of his work which he plans to complete as soon as possible.—THEO. JUST.

A LIFE OF TRAVELS. C. S. Rafinesque (a verbatim reprint of the original, Philadelphia 1836). Chronica Botanica Volume 8, Number 2. The Chronica Botanica Co., Waltham, Mass. G. E. Stechert and Co., New York City. 1944, 68 pp. and 3 portraits. $2.50.

Rafinesque, one of the most remarkable men in American botany, revealed a great deal of his dynamic, multi-facetted character in the writing of his life of travels. Many

botanists, and laymen as well, will appreciate the reprinting of this rare and unusual chronicle.

From the standpoint of Rafinesque, the reprint has received something resembling a "kiss of death" in the form of a foreword by E. D. Merrill, of Harvard. Merrill has done much to revive interest in Rafinesque's work but he gives a frank evaluation of it as part good and part bad — a judgment which Rafinesque undoubtedly would challenge as restrictive of the recognition he believed would ultimately be made of his work.

Rafinesque, of course, was a splitter, and, according to Merrill, had an "unbridled tendency" to name new forms. At the time, when it would have been relatively easy to accept new names, the contemporaries of Rafinesque ignored his work. It seems possible, in the light of present knowledge, that Rafinesque's taxonomic ideas may have been strongly influenced by his precocious concept of evolution (expressed in 1832) in which case his naming of new forms was perhaps not without reason.

Although accused of the fatal weakness of scattering his efforts, Rafinesque was not a trifling man. He is credited with having a herbarium of over 40,000 specimens, possibly the largest of this country in his day. Unfortunately his work was not well received, taxonomists wishing that he had done less instead of more — but, at the same time, wishing they could now buy the plants Rafinesque vainly tried to sell during his lifetime to further his work.

A Life of Travels is an interesting and relatively objective account of Rafinesque's many trips and experiences, both abroad and in this country. He was not a desk-top systematist as his numerous collecting excursions testify. His first plant collection after arriving on this continent was symbolic, perhaps, of his life in America; the plant was — and is today — *Draba verna*, although Rafinesque, thinking it a new form, called it *Dr. Americana*. As he said, American botanists would not believe him.

For a man whose scientific work was not in very good repute and who held a university position only a short time during his life, Rafinesque kept excellent company. He was personally acquainted with many important scientists and maintained correspondence and exchanges with many more. He seems to have invariably sought out the more accomplished people of his time whether they were scientists or not; since he seems generally to have been well received it is probable that he in turn was sought after.

One of the most interesting of Rafinesque's experiences occurred in Kentucky. During his absence the president of the college broke open his rooms and threw Rafinesque's belongings in a heap, and deprived him of the position as Librarian. Rafinesque left with curses on the president and the school. The president died of yellow fever the following year and in 1828 the college burned with all its contents.

Botanist, zoologist, geologist, paleontologist, merchant, inventor, all these were Rafinesque; in these capacities, however, he was frequently without any visible means of support, and it is difficult to understand how he maintained himself and his scientific work during many periods of his life. Probably it was the need for funds which drove him into additional occupations such as medical botany, geography, banking, and others. In one instance he relates how he cured himself of consumption with medicine of his own invention. He then arranged for the manufacture of his vegetable remedy and became a Pulmist — specialist in the cure of consumption — a business which succeeded well.

Near the end Rafinesque expressed the hope of attaining further accomplishments: societies of united learned men, steam plowing, incombustible houses and ships, societies of industry, etc. But showing a note of discouragement in 1836 he wrote, "Whatever be my future fate and field of exertions, I shall not have lived in vain — . My works, researches, travels, collections, etc., will remain as a proof of uncommon zeal, altho' unrequited and unrewarded." He died four years later.

A Life of Travels is — as intended — an excellent introduction to Rafinesque and his works as well as a log of his collecting trips. With the critical index by Francis W. Pennell this reprint edition is an excellent contribution to Americana and will greatly aid the studies of early American systematics. — NOE HIGINBOTHAM.

PACIFIC SCIENCE, a quarterly journal devoted to the biological and physical sciences of the Pacific Region. Published by the University of Hawaii, Honolulu. Annual Subscription, $3.00.

The new journal appearing under the auspices of the University of Hawaii is published on good paper in pleasing format, using the now preferred two column text, and with excellent figures. The four articles in the first number — one botanical, one oceanographic, one on soil chemistry, and one zoological — are all on Hawaiian subjects. The first of these, St. John's account of the sandalwood on Oahu, is made interesting to the general reader by its historical presentation and assessment of the present status of this interesting tree on the island. The article on the tsunami of April 1, 1946, presents the excellent case for the use of this term rather than "earthquake wave" or any other term, with a vivid account of a typical manifestation of this great and essentially Pacific phenomenon. An account of changes in the soil chemistry resulting in dolomitization bears naturally on a partly geological and partly agricultural interest. An excellent account of the habits, history of naturalization, and ecology of the red-billed *Leiothrix* (misnamed the Japanese hill robin) introduces the interesting subject of naturalization of foreign species on Pacific islands. The recommendations of the Pacific Science Conference are printed in the section for notes.

A few trivia may be called to the attention of the editor. The beginning pagination is confused by including the cover and a blank sheet, which are not numbered at the back, and will confuse equally the meticulous and the careless librarian and binder. Webster's dictionary is cited as preferred authority for capitalization, but the common names of birds are capitalized, while plant names are printed correctly in lower case.

It is to be hoped, and there is every reason to believe, that *Pacific Science* will live up to its name as a journal for the broad field of the Pacific region as a whole. It would aid in attaining broad coverage to add a consulting editorial board of Australian and New Zealandian, Dutch, Chinese, Japanese, Russian, and continental American membership.

. The importance of the new journal may be expected to grow as some of the far-flung plans for Pacific surveys discussed by the Pacific Science Conference materialize under the continuing stimulus of the Pacific Science Board. — KARL P. SCHMIDT, Chicago Natural History Museum, Chicago, Ill.

REPTILES AND AMPHIBIANS OF THE NORTHEASTERN STATES. By Roger Conant. Philadelphia Zoological Society, Philadelphia, Pa., 1947, pp. 1-40, illus., $1.00.

The new regional account of the perennially interesting frogs and toads, salamanders, turtles, lizards, and snakes is held at a strictly popular level, but at this level is our extraordinarily useful introduction to its subjects for the younger or the amateur naturalist. The essays introducing each group are interesting, competent, and noteworthy as suggesting the variety of interesting topics about the animals treated other than the mere problem of naming.

As an aid to identification, the excellent pictures, most of which have appeared in the pages of *Fauna*, will be extremely useful in this assembled form to the school teachers and school children who may be envisaged as the principal users of this work. The more conscious herpetologists appear to be so uniformly pamphletophilous that the reviewer anticipates that an early reprinting of Mr. Conant's paper will be required.

The regional limits, and the idea of the regional account, point to a matter of serious importance. A great and unfortunate duplication of effort is involved in the continuing production of "State" herpetologies and of similar state limited accounts of other groups of animals. If the continent could be divided into its natural geographic regions, and competent accounts of the fauna prepared region by region and group by group, a half dozen works of book-size and of continuing usefulness would result for each major group of animals. It is perhaps too much to hope that state organizations

might cooperate in bearing the costs of preparation and publication of such works, though great savings would be involved over the present custom of preparing and publishing works exactly similar in scope except for the artificial limits of state boundaries. — KARL P. SCHMIDT, Chicago Natural History Museum, Chicago, Ill.

STUDIES OF SOUTH AMERICAN PSAMMOCHARIDAE. Part 1. By Nathan Banks. Bull. Mus. Comp. Zool. Harvard, Vol. 96, No. 4, pp. 311-525, 3 plates.

Part 1 of a projected three-part study of the wasps of the family Psammocharidae [or Pompilidae] inhabiting South America, exclusive of Chile, has just been published. The three subfamilies Pepsinae, Pseudageninae, and Cryptochilinae are included in this part, the remaining three subfamilies will be considered in the second part, the catalog and bibliography of all South American species will make up the third and last part.

Numerous new genera, subgenera and species are proposed. The genus *Pepsis* is broken into eight subgenera and keys to the species of each subgenus are given but the student using the paper is given no key to the subgenera and is left to dig out for himself the subgeneric characters. One wonders why the author (p. 376) places in *Pepsis* s. str. certain species that he knows to belong elsewhere. The second and third subfamilies have been prepared with keys to genera as well as to species. In all, 340 species are noted, of which 112 are considered as new to science. — E. A. CHAPIN, U. S. National Museum.

EVOLUTION. *International Journal of Organic Evolution.* Published Quarterly by the Society for the Study of Evolution. Ernst Mayr, Editor. Vol. 1, Nos. 1-2, 112 pp., March-June 1947. Subscription per volume $6.00.

Unlike many other fields of biological endeavor with their specialized outlets for publication evolution has so far been without its own journal. In fact much of the supposed confusion surrounding evolution may in large measure be attributed to this lack of a medium providing the necessary contact between students of this field representing all branches of biological study. With the close of the war this obvious need resulted in the organization in 1946 of the Society for the Study of Evolution and now of its new journal EVOLUTION.

As the Editor says in his Foreword "*Evolution* will bring together contributions on evolutionary questions from all fields of biology." Significantly "contributions will be accepted on the basis of merit regardless of the country of origin." Clearly both the Editorial Board and the contents of the first issue give ample assurance that these policies will be carried out. Published with the aid of a grant from the American Philosophical Society as the official organ of the youngest and most vigorously growing biological society, *Evolution* marks the beginning of a new era in the scientific study of evolution. No student of life, past or present, interested in any aspect of evolutionary thought and knowledge will want to be without it.—THEO. JUST.

REPRINT SERIES

(Reprints 1, 2, 3 were issued with volume 2, reprint 4 with volume 3 and reprint 5 with volume 5).

(1) RAFINESQUE, C. S.—Neogenyton. 1825 .... $ .25

(2) ———The Natural Family of Carexides. 1840 .... .50

(3) ———Scadiography of 100 Genera of Ombelliferous Plants, etc. 1840 .... 1.50

(4) ———Monographie des Coquilles Bivalves et Fluviatiles de la Rivière Ohio. Remarques sur les Rapports Naturels des Genres Viscum, Samolus et Viburnum. A Bruxelles. 1820 .... 1.50

(5) LECONTE, J. E.—Reprints of Monographs without plates 2.50

With 42 photographic copies of unpublished plates (7 × 8). .... Prices on request

———Two extra plates reproduced from originals in New York Botanical Garden .... Prices on request

PUBLICATIONS

AMMONS, NELLE.—A Manual of the Liverworts of West Virginia, 1940. Cloth .... $ 1.75

BAILEY, V.—Cave Life of Kentucky. 1933 .... 1.25

BARKLEY, FRED A.—Keys to the Phyla of Organisms Including Keys to the Orders of the Plant Kingdom. 1939. 44 pp., paper bound. Postpaid .... .75

CARPENTER, MATHILDE M. Bibliography of Biographies of Entomologists. 1945. 116 pp. .... .75

GREENE, E. L.—Manual of the Botany of the Region of San Francisco Bay. 1894. Bound cloth 2.00

Unbound 1.50

———Flora Franciscana. Part 2. 1895 .... .75

———Plantae Bakerianae. 1-3 .... 1.30

———Cybele Columbiana. A Series of Studies in Botany, chiefly North American. (All published). 1914 .... .75

JUST, THEO. (Editor)—Plant and Animal Communities. 1939. Cloth 2.50

KISTLER, ELLEN D.—Bibliography of the Botanical Writings of Edward Lee Greene. 1936 .... .25

SETTY, L. R. AND KENNETH W. COOPER—Studies in the Mecoptera. 1940 .... 1.00

TOWNES, HENRY K., JR.—The Nearctic Species of Tendipedini [Diptera, Tendipedidae (=Chironomidae)]. 1945 .... 1.00

WOLFENBARGER, D. O.—Dispersion of Small Organisms. 1946 .... 1.00

The University Press, Notre Dame, Indiana